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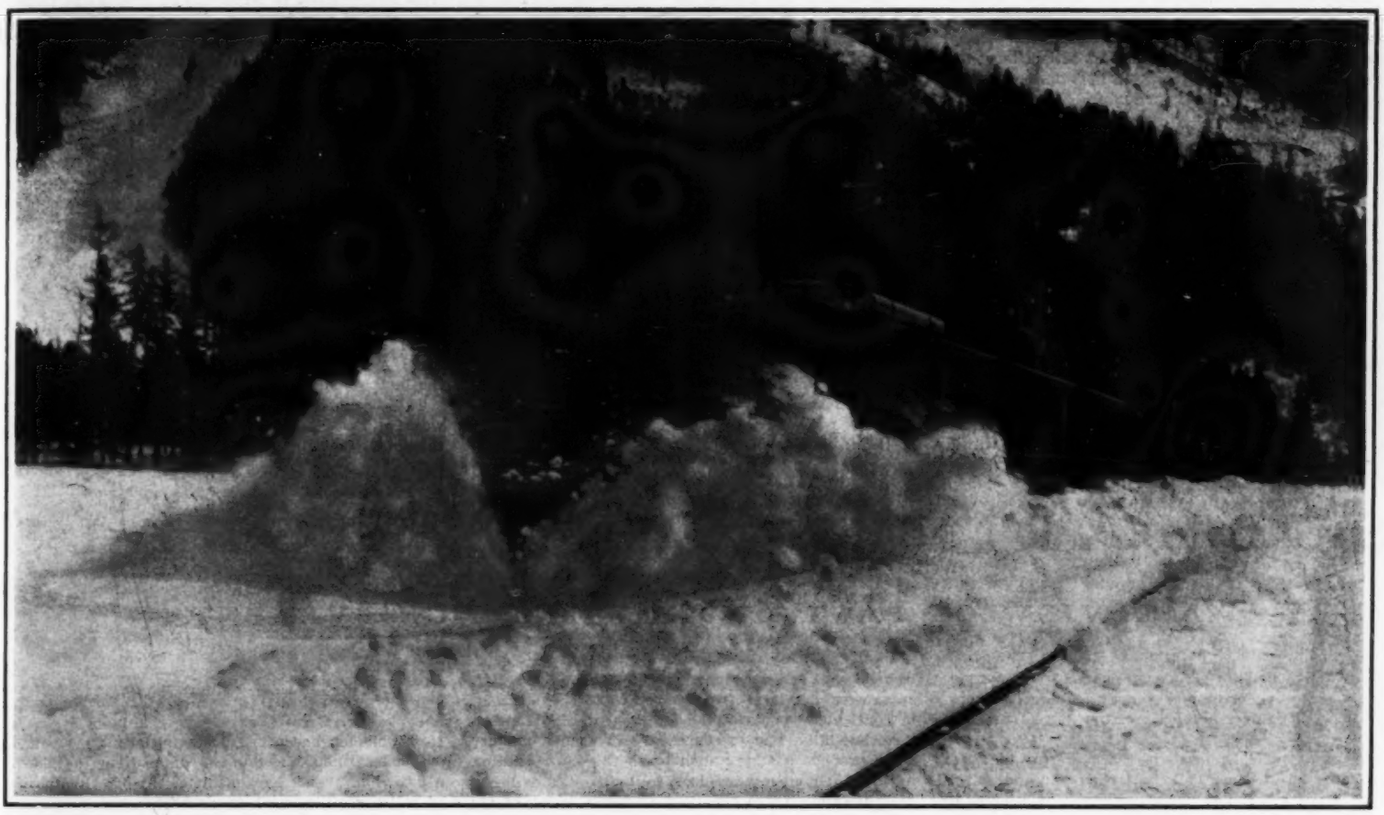
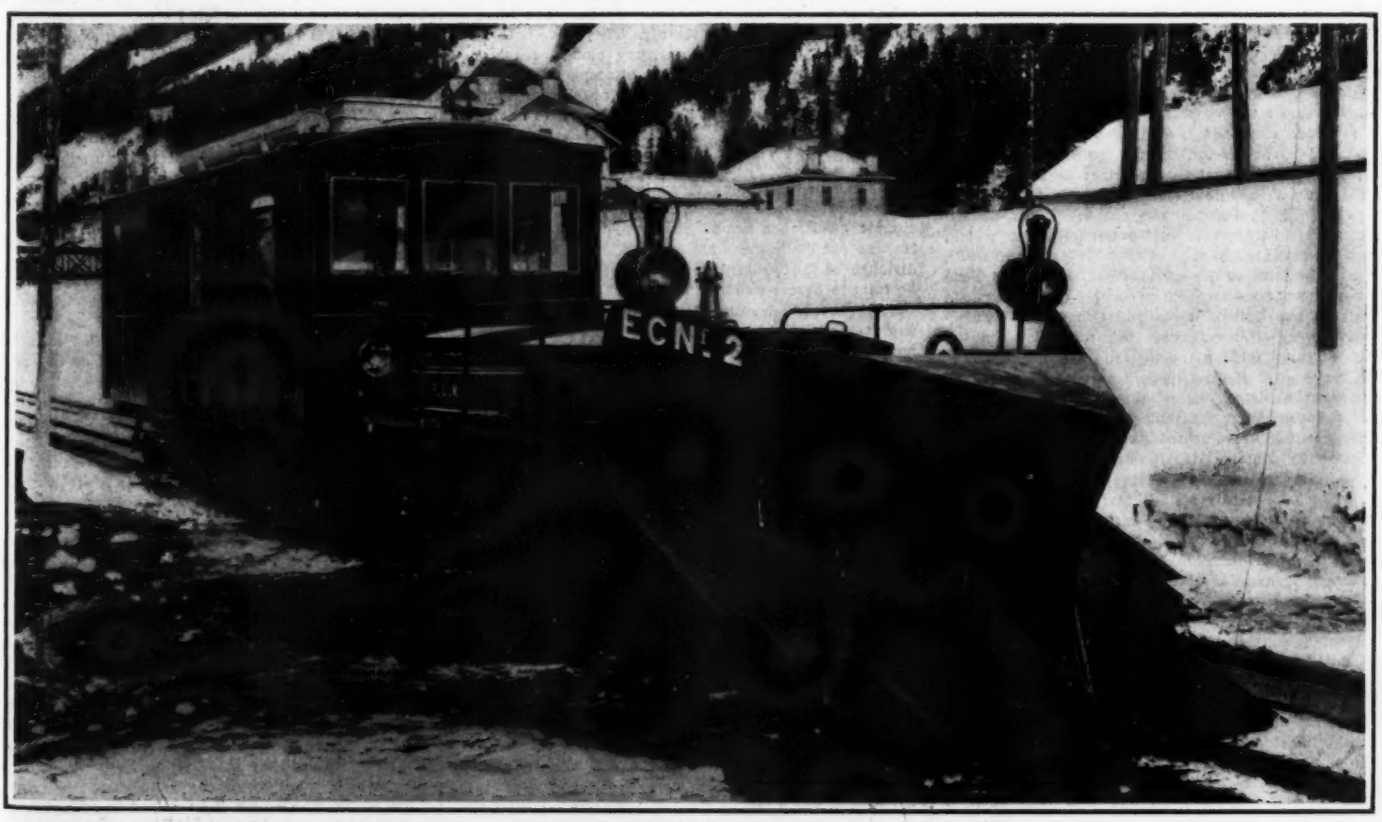


THE SNOW PLOW AT WORK.



THE SNOW PLOW OF THE FAYET-CHAMOUNIX RAILWAY.

A SNOW PLOW FOR AN ALPINE RAILWAY.

A SNOW PLOW FOR AN ALPINE RAILWAY.

AN INTERESTING ELECTRICAL LOCOMOTIVE.

BY DR. ALFRED GRADENWITZ.

LIKE many railways in the Swiss Alps, the Fayet-Chamounix electric railway was originally designed exclusively for summer service. Apart from the trifling amount of traffic to be expected, the heavy snows in the Chamounix Valley and the difficulty of clearing the road proved obstacles to a winter service.

The constantly increasing traffic, however, eventually led the railway company to consider winter operation. It was therefore necessary to provide some means for clearing the track and obtaining a satisfactory electrical contact. The front cars were provided with contact shoes of special construction which could scrape ice and snow from the third rail. A powerful snow plow was designed to clear the road.

This snow plow is propelled by two motors similar to those of the ordinary motor cars, which are of the quadruple pole type (with two consequent poles); the two exciting coils of each motor are mounted in series with the armature, which is of the toothed-drum type, with undulated windings allowing only two brush sets to be used. The number of collector lamellæ is 113. The inductor is of cast steel and constitutes a water-tight frame, consisting of two parts bolted to one another on a horizontal joint, and completely surrounding the armature, exciter coils, collector, and brushes. The latter are readily inspected through two windows in the upper half of the inductor. The lower half, in which are located the armature bearings, is provided with two cast-on arms pivoted on the axle, which, to this effect, is provided with an inside journal.

The two motors are invariably coupled in parallel, and can be insulated from one another in cases of emergency by means of fuse interrupters, located in a special box. They are suspended from the bogie by plate springs.

The motors are steered by a controller with magnetic blowing, intended to effect the starting, speed regulation, stopping, and reversing. The reversing is obtained by changing the direction of the current in the armatures, the starting by the gradual cutting out of resistances inserted into the motor circuits, and the speed regulation, by shunting the inductors.

The controller may occupy eleven positions, viz., a central position corresponding with the dead point with which the motor feeding current is interrupted, and five forward and five backward positions.

When the snow plow car travels separately, the controller is actuated by hand with a removable handle by the motorman posted on one of the platforms. When, however (which is the general case), the motor-plow forms part of a train, the controllers are actuated simultaneously from a distance by a motorman posted in the front compartment of the head car. To this effect, each of the controllers is connected with a compressed-air service-motor, fitted with two compressed-air conduits serving for forward and backward traveling respectively. These two conduits terminate in the front compartment of the head car in an apparatus called the "main service motor," provided with a steering wheel.

In order to put the controllers of all the vehicles composing the train at the position desired, the motorman has only to adjust the steering wheel of the main service motor to a corresponding position, turning it from left to right in forward, and from right to left, in backward traveling.

The four contact shoes are connected together by a system of joints and springs. They are of the same type as those used on the front cars for winter service, and comprise steel plates with sharp edges pressed down on the third rail by a compressed-air piston controlled by the motorman.

The snow plow proper has a triangular cross section with blades bent outward in a gentle curve, so as to form in the lower part, which comes in contact with the snow, a sharply-pointed blade inclined to the rail at a slight angle so as to offer a resistance as small as possible to any snow masses accumulated on the track. Trains of the following composition are formed for removing the snow:

(1) A snow-plow car at the head of the train.

(2) A baggage car with motorman.

(3) A number of motor cars, intended to increase the impact required for removing heavy snow masses.

These trains are able to remove snow layers upward of three feet, and sometimes even six feet in thickness, throwing them violently to right and left.

SUBMARINE SOUND SIGNALS.

A REVIEW OF PAST AND PRESENT ACHIEVEMENT.

THE following information on submarine sound signals has been published by the United States Hydrographic Office under authority of the Secretary of the Navy.

Over-sea traffic has exercised a powerful influence upon the advancement of civilization and the world-wide benefits that flow from counteracting sources of delay and danger in oceanic voyaging has never ceased to prove a stimulus in the search for more definite and accurate aids to navigation. Most of the prominent points of those coasts to which commerce has spread throughout the world are marked with beacons by day and with lights by night, but even if the time should have already arrived, as doubtless it some day will, when all the coasts of the United States had been defined from end to end by a band of light by night and by buoys and beacons, prominently placed, to be seen by day, yet to a mariner encompassed in thick fogs all such guides and warnings would be of no avail. Fog obscures the characteristics of the most powerful light and blots out those marks which, when presented to the view, serve to guide and to warn.

In many parts of the world, especially in the Temperate Zones, fogs frequently occur. On the eastern coasts of the United States and Canada an easterly wind is very often attended with fog. Between the Gulf Stream, flowing northward in the Atlantic, and the coast of the continent a current moves to the southward, bringing to the shores of Canada and the United States water from the Arctic Zone. With an easterly wind, air warmed and fully charged with moisture by contact with the Gulf Stream is blown across this cold current, and the suspended vapor is chilled and frequently condensed in the form of fog. The embarrassments thus arising to shipping on the coast of America stimulated the people of the United States to be pioneers in the employment of sound signals for combating the adverse influences of foggy weather upon commerce and navigation, for, aside from the possibilities of wireless telegraphy, the sense of hearing is the only means by which human perception may be apprised of the dangers lurking in coastal waters when the sense of sight is unavailable.

Until recent times the sound signals generally used to guide mariners, especially during fogs, were, with certain modifications, sirens, trumpets, steam whistles, bell boats, bell buoys, whistling buoys, rockets, gongs, bells struck by machinery, and cannons fired by powder or gun cotton. In connection with all these implements the atmosphere is the medium of transmission of the sounds emitted from the sounding apparatus; but it is a characteristic of the air that, in contiguous spaces of the atmosphere, the temperature, humidity, and pressure vary in such a manner as to produce a state which bears the same relation to sound as cloudiness does to light. Tyndall has thus described these conditions: "By streams of air differently heated, or saturated in different degrees with aqueous vapors, the atmosphere is rendered flocculent to sound. Acoustic clouds, in fact, are incessantly floating by through the air. They have nothing whatever to do with the ordinary clouds, fogs, or haze, and the most transparent atmosphere may be filled with them, converting days of extraordinary optical transparency into days of equally extraordinary acoustic opacity."

THE INADEQUACY OF AERIAL SOUND SIGNALS.

The mariner has long since learned to be exceedingly cautious about depending upon aerial sound signals, even when near. Experience has taught him that he should not assume that he is out of hearing distance of the position of the signal station because he fails to hear its sound; that he should not assume that because he hears a fog signal faintly he is at a great distance from it, nor that he is near because he hears the sound plainly; that he should not assume that he has reached a given point on his course because he hears the fog signal at the same intensity that he did when formerly at that point, neither should he assume that he has not reached this point because he fails to hear the fog signal as loudly as before, or because he does not hear it at all; and that he should not assume that the fog signal has ceased sounding because he fails to hear it, even when within easy earshot.

While both the range and the certainty of the transmission of sounds through the air may be enhanced by imparting such excessive energy to the sound waves as to render them less liable to the dissipating influences of a variable atmosphere, yet, with the fog signals heretofore in use, it has been impossible to distinguish, by any means available to the mariner at sea, the times when he might expect aberrations in audition from the times when the sounds would be heard normally as to force and place.

THE SUPERIORITY OF WATER AS A MEDIUM FOR THE TRANSMISSION OF SOUNDS AT SEA.

Water is less a mobile medium than air, less responsive to marked variations of density arising through changes in temperature and pressure, and, therefore, less subject to variations of homogeneity, and more reliable as an agency of the transmission of sound waves. In his experiments on Lake Geneva, in 1826, Colladon had a bell, weighing about 150 pounds, suspended some 5 feet under water from the side of a boat, and struck by a hammer attached to the end of a lever. Stationed in another boat, he listened for the bell sounds propagated beneath the surface, which were conveyed from the water by a cylindrical tube of tin some 9 feet long and 6 inches in diameter. One end of this tube terminated in an orifice for insertion in the ear, and the other was spread out somewhat in the form of a spoon, with its orifice closed by a flat, elliptical plate of tin about 2 square feet in area. By attaching a suitable weight to the lower end of the tube it was easily retained in a vertical position with about four-fifths of its length submerged, its flat plate being turned toward the boat carrying the bell. With this simple apparatus Colladon was able to hear, with perfect distinctness, the blows of the hammer on the bell across the widest part of Lake Geneva, when the calculated distance between the two boats was not less than 8 miles. The sounds which he heard appeared as if they had been caused by some metallic body striking the bottom of the tube, and they were as distinct at 8 miles as at a few hundred feet from the bell. One set of observations was made during a strong wind. The waters of the lake, which were at first calm, became violently agitated, and it was necessary to keep the boat in position by means of several anchors, yet, notwithstanding the noise of the waves that struck the tube, he took observations with the same accuracy as when the air and water were still. And he states: "I am convinced that by employing a bigger bell, and improving or enlarging the hearing apparatus, easy communication could be effected under the water of a lake, or of the sea, up to 15 or 20 leagues."

Plans for making a practical use of the water as a means of communication between vessels at sea commenced to germinate with the invention of the telephone in the latter part of the last century.

In his admirable work, entitled "The Modern Light-House Service," published as Senate Executive Document No. 56, Fifty-first Congress, first session, Mr. Arnold B. Johnson, chief clerk of the United States Light-House Board, has made reference to the experiments which were commenced in 1883 by Prof. Lucien Blake, whose plan is described as follows: "A sound-producing apparatus was to be attached to each vessel, and to be worked under the surface of the

water. In times of fog or at night a code of signals would be produced by it which would be transmitted in all directions through the water with a velocity four or five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with sound-receiving apparatus, which would take up out of the water the signals arriving from the neighboring vessels. For steamships the sound-producing apparatus was designed to be a steam fog horn or whistle, especially constructed to sound under water, and to be heard at least from 6 to 8 miles. . . . As to the receiving apparatus with which each vessel was to be provided, the original plan of 1883, and which has not been changed, was to employ some form of telephone acting as a transmitter under water and connected with a receiver within the vessel."

SUBMARINE SIGNAL BELLS.

It is along these general lines that the problem has been so successfully solved under the auspices of the Submarine Signal Company, of Boston, that the method of submarine sound signaling has been officially recognized as supplying an important aid in navigation. As early as 1903 the United States Light-House Establishment had furnished the light vessels at Boston, Nantucket, Fire Island, and Sandy Hook, with submarine fog bells. The equipment consisted of a bell with striking mechanism actuated by compressed air, suspended at a depth of 30 feet or so beneath the surface of the sea from a davit at the side of the vessel; a small and compact air compressor driven by a kerosene engine or by steam from the boilers of the lightvessel, for the purpose of furnishing power to operate the bell; and a code ringer also connected with the compressor engine, and adapted automatically to control the strokes of the bell so as to cause its ringing to send out the code number of the lightvessel.

The sound waves going out from the lightvessels below the surface of the sea could be heard for a distance of some miles by passing ships equipped with microphones to receive submarine sound signals. These sound receivers are located inside the hulls of ships below the water line, and connected with the chart room or bridge by a telephone circuit. On either side of the forehold there is fitted a small tank on the inside of the skin of the ship without cutting the plating or making any alteration whatever in the hull of the vessel. A small opening in the top permits the introduction into the tank of a dense liquid in which the receiving microphones are suspended. By listening at the telephone, whose circuit includes both the port and starboard microphones, and switching the instrument from the starboard to the port microphone and back again, the tones of the lightvessel's submarine bell could be heard on coming in range of it. If the tone was louder on the starboard side than on the port, the mariner would know that the lightvessel was on his starboard side, and if the tone was exactly the same in both microphones, he would know that the lightvessel was dead ahead.

It was found that even in the case of vessels to which the sound-receiving microphones had not been fitted, a listener, putting his ear to the inner surface of the plating, say in the empty forepeak below the water line, could hear the sound proceeding from a submarine bell several miles away; but under such circumstances no information is derived as to the direction from which the sound proceeds, and hence a vessel encompassed in fog could not be steered by bell, and must suffer a denial of those advantages that come from the knowledge of direction that is derivable on board of vessels in which suitable instruments have been installed to receive the sounds.

The substantial service rendered to shipping by the submarine bells first established decided the United States Lighthouse Board to extend their installation, from time to time, to other lightvessels until, at present, 46 of the lightvessels in the waters of the United States are thus equipped, and the signals which they send out are of undoubted aid to deep-water navigation.

Equally effective as aids to navigation are the submarine bells that have been fitted to buoys, where they are worked by the motion of the sea, and those that have been suspended from tripods on the sea bottom, where they are controlled electrically from shore stations and serve to give warning of dangers or to make turning points along the routes of commerce.

Many of the lightvessels and buoys of European waters have been similarly furnished with these bells, and they have been likewise established in the region of the Gulf of St. Lawrence; and, as the effective range of the submarine bell far exceeds that of aerial sound signals, having been known to exceed fifteen miles, and their bearing can be determined with sufficient accuracy for safe navigation in fog, if a vessel is equipped with receivers, it has seemed appropriate to set forth for the benefit of mariners a list of stations where they are at present established.

Remarkable endurance tests have been applied to some of these submarine signaling installations. From a cottage at Point Allerton, near Boston, in which a 2½-horse-power oil engine operated an electric generator, a submarine cable was laid to the shore, and thence 2 miles out into the harbor along the sea bottom. At the end of the cable was an iron tripod standing on the bottom of the ocean, 70 feet below the surface of the water, and on the tripod was a bell weighing 220 pounds, the clapper of which was actuated by powerful magnets. On March 30th, 1907, the current was turned on, and the bell began to strike at the rate of about 22 blows a minute, and continued until the 16th of May when the total number of strokes had reached 1,032,930 in a duration of 789½ hours.

The pneumatic bells on five lightvessels were also required to be rung continuously, night and day, for sixty-one days, making a period equal to two and a half years of service according to the highest demands made in past years upon the fog whistle on the lightvessel at Sandy Hook. Submarine bell buoys have also been tested. The fact that the bearing of the buoy can be found in fog or at night makes them advantageous to shipping when they are placed in exposed positions in water of sufficient depth to give the vessel steering for them sufficient space to maneuver for the purpose of locating the origin of the sound. It is noted that in restricted waters, or when the bell is located near steep banks or rocky shores, an echo may be expected; and this fact requires that the proposed location should, in each case, be thoroughly investigated by experiment, because there are possible situations where the echo may be heard instead of the direct sound, and thus lead to an erroneous determination of the place of the danger which the bell is intended to mark.

The mechanism for submarine bell buoys is dependent on wave motion for its power, and, therefore, differs from that of the electrically-controlled tripod bell and also from the pneumatic bell employed in connection with lightvessels. On the trunk or stem of the buoy is a float or "sea anchor," free to move up or down for a short distance and ballasted so as to have, as nearly as may be, the same weight as sea water. It is the design that this shall remain practically stationary as the buoy rises and falls. The pull rod of the clapper is connected to a crank on a toothed wheel which is turned by a ratchet-and-pawl gear operated by two arms attached to the sea anchor. Of special interest in connection with submarine-signal buoys are the gas buoys which have been experimentally fitted with bells that are rung through mechanism actuated by the pressure of the gas supplied for the light, and are thus independent of the action of the waves as an agency for ringing the bell, and consequently free of the liability to irregularity in the intervals between the strokes of the clapper, which precludes the successful ringing of a code signal.

COMMUNICATION BETWEEN VESSELS AT SEA.

Beside their usefulness in warning vessels of their approach to the land and to dangers, submarine sound signals may be used as a means of communication between vessels at sea. For this purpose the sound-producing bell, immersed in water held in a tank, is installed, in the fore-peak of the vessel, inside of the hull, and may be operated automatically or by hand. As a means of communication between submarine boats in a state of submergence, this method of signaling has a special field of utility. During the tests of submarine boats in May, 1907, communication was, in this manner, kept up between the "Octopus" and the tender "Starling." Signals were communicated from the "Starling" to the "Octopus," telling when the latter had crossed the finish lines, and when to come to the surface, and distinct messages were received in return from the submerged vessel.

THE EQUIPPING OF VESSELS WITH SUBMARINE SOUND RECEIVERS.

The maritime community has availed itself more and more of the facilities which have thus been provided by the fostering care of various governments with a view of lessening danger in navigation and delay in transportation and an increasing number of vessels have, year by year, been furnished with submarine sound receivers, and, for the convenience of underwriters in determining rates of insurance, the American Bureau of Shipping has noted in "The Record of American and Foreign Shipping," which of the vessels are so equipped.

The saving of time brought about by enabling vessels to reach port instead of being delayed by fog and losing tides is being constantly exemplified. The "Lucania," while approaching New York on one occasion made all three lightvessels by submarine-bell sounds, which constituted the sole guide; and we read in the Cologne Gazette that the captain of the "Kaiser Wilhelm der Grosse," during the course of a voyage to New York, when surrounded by a dense fog off the coast near Fire Island lightvessel, heard the submarine bell and was able to steer by it, when, as it subsequently transpired, he was twelve nautical miles distant from the signal station. At 6:45 A. M. the sound of the bell was heard to starboard, and, owing to the fog, the ship, which was some distance out of her position, was guided solely by these bell signals, and the course was altered by the sounds heard from the lightship, though the fog horn was wholly inaudible.

THE RANGE OF AUDIBILITY OF SUBMARINE BELLS.

While careful listening at the telephone is always a requirement that must not be underrated nor overlooked, it is found that vessels of deep immersion have an advantage in the range of distance at which submarine sound signals may be detected, and this is accentuated in cases where they are moving at a slow rate of speed. Indeed, on the Great Lakes, where the forepeaks of vessels are frequently above the water line, special provision was necessary for the proper submergence of the tanks containing the sound receivers.

There appears to be no failure to hear and recognize the sounds of the submarine signal bells at distances between three and five miles, and on the average these distances are considerably exceeded.

What range of submarine transmission of sound waves will ultimately be set as the limit of practical audibility of such signal bells is not now known, but the possibility of a comparatively extended range, under special conditions, is foreshadowed in the observations that have been lately made between the lightvessel "Gabelsflasch," located at the entrance to Kiel, Germany, and the lightvessel "Fehmarnbelt," situated nearly twenty-seven nautical miles away. On different occasions the ringing of the submarine bell on the latter lightvessel was heard by the unaided ear through the naked walls of the carpenter's store room on the "Gabelsflasch" vessel. Without doubt this remarkable transmission was favored by the form of the sea bottom, which, while not of an even depth in the region between the lightvessels, does not suffer any sudden or great irregularities; and, perhaps, the energy of the sound waves, freed of interference by the intrequency of traffic in midwinter and by the absence of agitation of the waters from storm, was conserved and strengthened by the narrowing shape of the borders of this portion of the German sea.

Although there are some situations in which the submarine sound signals are cut off, as, for example, when an underwater formation, like a bank or shoal, rises from the bottom and culminates near the surface of the sea, these observations on the "Gabelsflasch" vessel indicate that conditions may be found or arranged which will be exceptionally favorable for the distant transmission of signals. Thus, where there is a funnel-shaped entrance bounded by jetties runing far out into the sea, it may be practicable, by the concentration of waves from an origin of sound placed near the vertex of the funnel, to mark out a sharply-defined sound sector for the purpose of locating the entrance when it is obscured by fog or darkness.

LUBRICATION UNDER PRESSURE.

LUBRICATION under pressure has been applied with success to dynamos, turbines, internal combustion motors and other high speed machines, and within the last three years it has been applied to the great marine engines of British warships. About 1 gallon of oil is used per hundred horse-power per day of 24 hours and, as part of the oil can be recovered and used again, the process is very economical. The apparatus used for dynamos and small motors consists of a single oil pump, operated by an eccentric. The apparatus employed in the British navy usually includes for each engine three oil pumps driven by steam, an oil tank and a vessel for the separation of oil from the water of condensation, in addition to the necessary pipes and filters, and a collector for exuding oil. In order to prevent rapid clogging of the conduits it is necessary to use a non-saponifiable oil, free from resin.

As the dimensions of ships are being continually increased, for the purpose of augmenting either speed or carrying capacity, the ports, docks, and channels of the world are becoming insufficient for the demands made upon them. Hence shipbuilders are compelled to remain within certain limits of length, breadth and, especially, draft. The result is that the new vessels do not possess the requisite stability and displacement and that shipping companies complain that they are unable to make full use of their costly equipment. Many ports, docks, and basins are being improved and enlarged, but these great works, designed in accordance with the dimensions of the largest vessels now afloat, are not yet finished, and the dimensions of newer ships are increasing in unforeseen proportions. The "Umbria," built in 1883, had a length of 502 feet, a draft of 27 feet, and a speed of 17 knots; the "Mauretania," built in 1907, has a length of 790 feet, a draft of 37 feet, and a speed of 26 knots. Here the length has increased 57 per cent, but the draft only 37 per cent. Yet upon the draft depend the stability, the harmony of form, and the capacity of the vessel. Hence the enlargement of ports and docks is loudly demanded, but how shall the work be planned when the dimensions of future ships cannot be foreseen?

FRICTION DRUMS AND BRAKES.*

HOISTING-ENGINE ESSENTIALS.

BY WARREN O. ROGERS.

In hoisting-engine practice two of the important parts which must operate with certainty at all times are the friction drum and brake. When very heavy material is being hoisted, the engineer and all others concerned with the work want to be sure that the brake on the hoisting drum is going to hold when it is applied. In order that he may know that the brake and friction drum are in working order, it is advisable for the operating engineer to become familiar with the construction of various types.

In Fig. 1 is shown a friction drum which consists of blocks of seasoned hardwood fitted and secured to a projecting rim on the gear wheel. On the drum flange is cast a rim having a beveled surface on the inner side to correspond to the bevel of the wood pieces with which it engages when thrown into contact.

The drum is fitted to turn freely on the shaft, and also have a slight lateral movement on the drum shaft, sufficient to make contact on the friction drum with enough force to hold the strain of any load the engine can hoist. The drum is moved by means of a lever, attached to a screw, which makes contact when thrown into gear with a steel pin, two steel

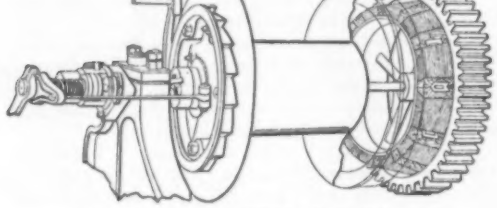


FIG. 1.—FLORY FRICTION DRUM.

plates and one of bronze, the latter being placed inside the friction nut. These plates are in oil receptacles which should be filled with lubricating oil.

The movement to release the friction is effected by connecting the end of the friction screw to the drum by means of a rod and yokes which, by a reverse movement of the friction lever, will positively disengage the friction under all circumstances. As an auxiliary, a recoil spring is placed on the shaft between the gear wheel and the drum, the pressure of which against the drum produces a gradual release. This friction drum is used on the hoisting engines made by the S. Flory Manufacturing Company.

A cone type of friction drum is shown in Fig. 2. It is lagged with either wood or mineral-tan leather. The spur wheel which carries one member of the friction is keyed against a shoulder upon the drum shaft. At the opposite end of the shaft is a collar threaded and secured to the shaft by a set screw, the end thrust when applying the friction being taken by the collar. A flange sleeve having an external thread of coarse pitch is placed between the collar and the drum hub, the flange and the sleeve having a number of holes spaced on a concentric circle. Through one of these hubs a screw passes and screws into the side frame to prevent the sleeve from ro-

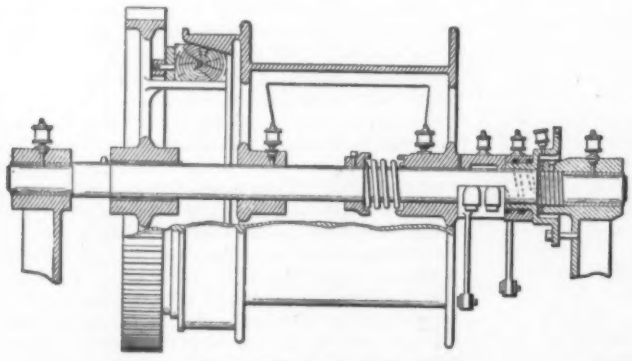


FIG. 2.—EXETER FRICTION DRUM.

tating. The wear on the friction is adjusted by turning the sleeve in the proper direction a sufficient amount, and the sleeve is then secured by means of the bolt placed in a hole in the frame that coincides with the hole in the flange.

On the sleeve is a hub with a lever for rotation. When rotated in one direction the friction is applied; rotated in the other direction the friction is released by the recoil spring. A loose-fitting stationary hub is placed between the operating sleeve and drum hub, and is provided with an extending arm to prevent rotation. This stationary hub is made in halves so as to be removable for relagging the friction if necessary. This friction drum is made by the Exeter Machine Works.

Another type of friction, or clutch, is shown in Fig. 3. The clutch runs loosely on the drum, and is fitted with a band friction clutch consisting of a disk keyed to the shaft which is fitted with two arms carrying a steel band, lined with removable basswood blocks and having a suitable means of adjusting the friction band by means of bolt and nut, as shown. One arm is bolted to the disk, and the other fulcrumed from it, and receives its motion from a combination toggle connection and rockshaft, which is operated by a hand-lever. In this type of friction the clutch is locked in either the on or off position and end thrust of the shaft is eliminated.

Fig. 4 shows the application of the friction which is fitted to the hoist put out by the Wellman-Seaver-

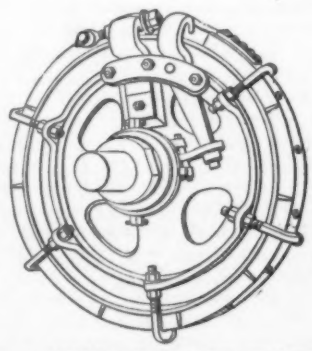


FIG. 3.—BAND FRICTION CLUTCH.

Morgan Company. The illustration also shows the band brake which is operated by an independent hand lever. The band is attached at one end to the foundation and at the other to the hand lever, the connection being such that a continuously increasing force is applied to the brake, while the operator pulls with uniform strength on the lever.

Another type of friction clutch is shown in Figs. 5 and 6, which show both sides as it appears when

FIG. 4.—APPLICATION OF BAND FRICTION TO DRUM.

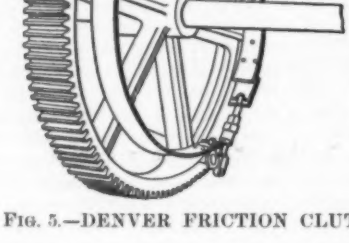


FIG. 5.—DENVER FRICTION CLUTCH.

FIG. 6.—ANOTHER VIEW OF THE DENVER CLUTCH.

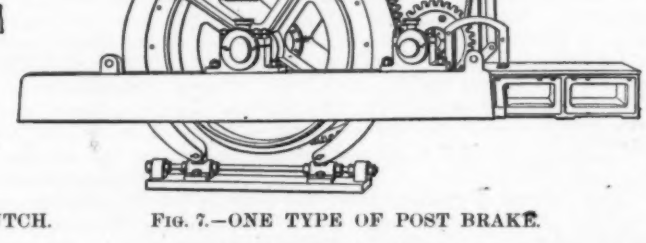


FIG. 7.—ONE TYPE OF POST BRAKE.

band are connected to a pair of bell cranks mounted on the rockshaft, which passes through bosses cast on the rim of the main-drum gear, as shown. On the opposite ends of each rockshaft, carrying the bell crank, is forged a lever arm that reaches to opposite sides of the gear hub and shaft in Fig. 6. These arms are connected by means of rings to the clutch sleeves that slide on the drum shaft. On the outer end of the sleeve is a groove which engages the clutch fork, and is in turn operated by the clutch lever at the operator's stand. As the clutch sleeve is moved toward the gear, the link forces the ends of the long lever outward, which actuates the bell crank so as to draw all four ends of the clutch band together. This clutch is self-locking, whether open or closed.

In Fig. 7 is shown a type of post brake, consisting of two beams placed vertically, each partially encircling the brake ring on opposite sides. The beams carry a large wooden wearing block, the side next to the brake rim conforming to a circle. Both brakes are controlled by hand levers. The types of brake shown in Figs. 5, 6 and 7 are made by the Denver Engineering Company.

A cork-insert friction is illustrated in Fig. 8, and is made by the Lidgerwood Manufacturing Company. The gear wheel of the drum is fitted with a friction flange, as shown, in which are fitted cork inserts which are allowed to project about 1/32 inch above the wooden-flange rim, and although contrary to what one would suppose, as the wood of the friction wears away the cork retains its original amount of projection, the wear seemingly being proportional. As cork will not burn as readily as wood, and does not slip as easily, the cork is very durable. Another feature is that oil does not affect its holding power, and trouble from slipping is practically eliminated, even though oil should get on the friction drum.

In Fig. 9 is shown the design of the friction pin used for this type of friction drum. It consists of a coarse-pitch screw to which is attached the lever for operating it. The screw when turning comes in contact with a friction pin which is placed in an oil box, and being submerged in oil eliminates what would be serious friction losses, as well as any possi-

* Power and the Engineer.

bility of the pin and screw becoming welded, due to dirt and friction. As the oil box is inclosed, foreign matter is prevented from getting into the oil, and the pin and screw are kept clean; at the same time sufficient lubrication is always provided.

A friction of the double V-type is shown in Fig. 10, and is made by the Clide Iron Works. It is composed of long segments of hardwood bolted to the spur wheel and turned to fit the faced friction surfaces in the drum flange with which they engage when in gear. These friction blocks are arranged with the grain radial and present a large area of friction surface across the grain. Owing to the angle of the friction and friction block a very slight movement of the drum along the shaft is sufficient to engage it, which makes it a positive and powerful friction.

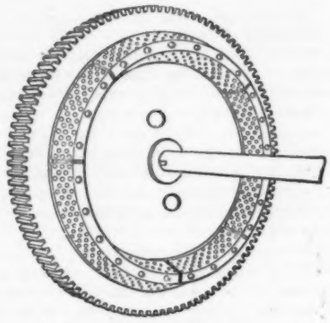


FIG. 8.—CORK INSERT FRICTION.

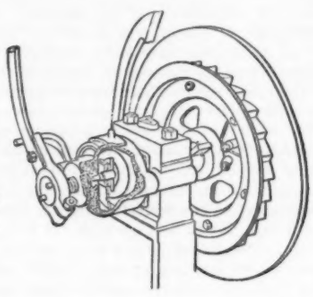


FIG. 9.—LIDGERWOOD FRICTION PIN.

The friction engagement is accomplished by means of a forged-steel lever, friction screw and nut, placed at the end of the drum shaft between the drum and motion to the drum by means of a tool-steel pin crosskey and collar. This friction arrangement is so efficient that a very slight pressure on the lever is sufficient to hold the drum in gear against any load the engine may handle.

The release of the friction is automatic when the pressure is removed, due to the heavy steel spiral spring, which encircles the drum shaft between the drum and gear wheel, and the end pressure against the thrust members exerted by this spring is relieved when the drum is thrown off. The spring is confined by a steel check bolted to the gear wheel to allow for adjustment when needed. This spring-check device removes all resistance to free unwinding of the drum, and at the same time prevents the spring from exerting a pressure on the thrust member.

In Fig. 11 is shown an outline drawing of an Otto gasoline mining hoist. The thrust collar which takes up the thrust when the friction clutch is thrown in is screwed to the drum shaft. The friction surfaces are inclosed in a box filled with oil or grease, which protects them from dust and dirt.

The brake is of the differential type, and the load tends to tighten it after it has been applied. The brake bands are lined with blocks of hardwood and are made in two sections, joined by a bolt with nuts to adjust for wear.

The load is hoisted by throwing the drum in gear and lowered by applying the band brake. As shown, the operating levers are mounted in a rack and so arranged that the operator faces the shaft. The clutch lever is connected to a speed-changing device, the speed of the engine being automatically reduced when the hoist is not in actual operation or when the load is being lowered.

MODERN MARINE BOILERS.

THE survival of the fittest is abundantly manifested by the Scotch boiler, which after passing through many vicissitudes, is still the most popular with the shipowner. That it has given place to a large extent to Babcock and Yarrow boilers in warships is in nowise remarkable, because conditions of working and upkeep prevail in the navy which are very different from those obtaining in the mercantile marine. But it must not be forgotten that its success alike in our greatest Atlantic liners and our smallest ocean tramps is mainly due to causes which are not closely concerned with the general design of the boiler.

It is clear that the workmanship and material of a boiler have next to nothing to do with its evaporative efficiency. So long as the boiler does not leak, a square foot of heating surface is just as good, other things being equal, in a weak, badly made boiler as it would be in a boiler of the best possible construction. This means, in other words, that the Scotch or return-flue marine boiler found its way to the hearts of the shipowners while pressures were very low, plates thin and small, and workmanship poor when judged by modern standards. As time went on safety valve loads augmented, and it was argued that only the water-tube or locomotive boiler could stand the stresses. But shell plates were rolled at moderate prices, daily larger and thicker, and this more rapidly than pressures rose. Then it was said that although shells might comply with the conditions, furnace tubes could not. The answer to that was the corrugated flue. In one word, the steel manufacturers were able to supply plates, and the boilermaker to use them, in a way which met any possible demand for high pressure. The notable fact is that the design of the boiler lent itself easily to the utilization of thick plates, just as well as it did to the utilization of thin plates. We are prone to forget, nowadays, the importance of the part played by good workmanship and good material, in perpetuating types which must have become obsolete without them. Every advance that has taken place in the economical production of power at sea has been in the first place due to an increase of pressure. While the pressure remained at 30 pounds, nothing whatever was gained by compounding. The introduction of a second cylinder had no effect, unless to augment the weight of steam required per horse-power hour. In like manner, triple-expansion with 75 pounds to 80 pounds steam meant waste. The presumed effect of reduction of range of temperature in each cylinder had no existence. The pressure jumped to 130 pounds and 150 pounds, and lastly to 160 pounds. Now we have quadruple expansion; but to make it pay the pressure is 200 to 220 pounds, and these last enormous pressures are carried with perfect safety in gigantic boilers, still of the Scotch type. The thing would be wholly impossible were it not for the improvements which have been made in rolling mills, and in the machinery of our boiler yards. Twenty-five years ago no one would have dreamed of designing a Scotch boiler 15 feet in diameter, with shell plates 2 inches thick. Modern plant has rendered the manufacture of such boilers a matter of certainty, and that on a perfectly satisfactory commercial basis. We are very liable, when criticising our predecessors, to forget that much that was known to them to be desirable was also known to be impossible.

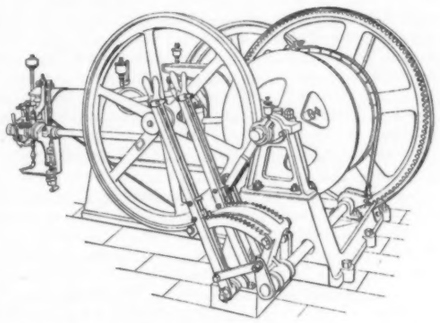


FIG. 11.—DRUM AND BRAKE OF OTTO GAS ENGINE HOIST.

Nor is the end even yet in sight. Lloyd's and the Board of Trade used to stipulate that no steel over 38 tons or under 26 tons should be used in a boiler. These rates were modified, and now Lloyd's no longer stipulate for anything save that their engineer surveyors shall be satisfied. It is by no means impossible that 60-ton steel may be used at no distant period. It is now, we may say, simply a question of price. But inasmuch as the weight of a boiler made of high steel would be little more than 60 per cent of that of a boiler made of low steel, there is, it will be seen, a considerable margin available. As far as mere saving in weight is concerned, however, it is doubtful if the owner of large ships would attach any particular importance to it.

It is clear that the closing of 1¾-inch rivets is quite beyond the power of manual labor. It follows that but for the riveting machine we should have no thick boiler shells. At every turn, indeed, we have the interdependence of the arts brought before us. The facts are put very much in evidence by a few passages contained in an excellent practical paper on "Marine Boiler Design, Construction, and Economy," read before the North-East Coast Institution of Engineers and Shipbuilders, on the 29th of October, by Mr. D. Myles. After referring to the time when ship riveters and caulkers were employed in making boilers when they were not wanted on the ships—a practice now quite out of date—he went on: "Along with the improvement in workmanship, there have been vast improvements made in machines used in the manufacture of boilers. The holes for stay tubes, which a few years ago were tapped by hand, are now almost universally accurately tapped by machine, and this applies also to stay holes between combustion chambers, boiler backs, etc., and a hole tapped by machine is more likely to be true and fair than one tapped by a man pulling at the end of a long single-ended lever, as was frequently the case in former years, and if the hole is truer the screwed stay will necessarily be a better fit." One result of all this is that the only limit to the size of a boiler is economy in working. Double-ended boilers, carrying 190 pounds, and weighing over 100 tons, are in use, and giving much satisfaction. The weak point about these heavy boilers is the calking. No method of welding is trustworthy; but it would not seem to be impossible to devise some method of electrical or blow-pipe welding by which the edge of one plate might be fused autogenously, if we may use the word, on the surface of the other, riveting having, of course, first been done in the usual way.

One fact we commend to the attention of those who believe that reduction in the size of a boiler is a highly desirable prize. Mr. Myles points out that the whole modern tendency is to make boilers larger instead of smaller. Thus combustion chambers are made much deeper than they were, with great benefit; and more room is left between the shell and the tubes. Nothing has struck him more forcibly "than the great change of opinion and practice with regard to crowding a large amount of heating surface into the smallest possible boiler, thereby reducing the space for cleaning and examination and otherwise making the boiler unsatisfactory. Boilers, which a few years ago were considered large enough to contain about 2,400 square feet of heating surface, are now usually made 9 inches or 12 inches larger in diameter. This extra size is due to a large number of causes, the principal of which are the larger spaces between combustion chambers, between nests of tubes, and between steam space stays, thereby making the boiler much more accessible for cleaning; and as ships' engineers, together with boiler cleaners, are very human, the boiler that is not easily accessible is very liable to go improperly cleaned, and the opposite, of course, also holds good, that a boiler easily accessible is much more likely to be thoroughly cleaned, and in boiler treatment cleanliness is of the very highest importance if long life and satisfactory results are to be obtained." It is frequently forgotten by professional boiler designers and always forgotten by amateur designers, that much more has to be kept in view than the combustion of coal and the making of steam. Apparently small matters may make a great difference. No mistake is more common or more harmful than the crowding of too many tubes into a shell. Boilers have this in common with animals, that they must have room to breathe.—The Engineer.

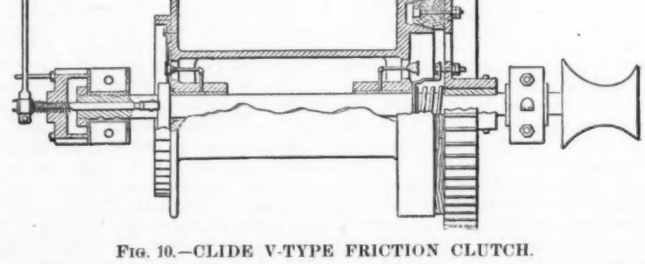


FIG. 10.—CLIDE V-TYPE FRICTION CLUTCH.

INDUSTRIAL ELECTROLYSIS.

THE EMPLOYMENT OF ELECTROLYSIS IN CHEMICAL MANUFACTURE.

BY PROF. B. LEPSIUS.

ALTHOUGH electrolysis was introduced into manufacturing chemistry in the eighties, the chief chemist of the English United Alkali Company, in 1888, pronounced the electrolytic production of soda chemerical. This may be the reason why this method was not sooner employed in England, but it is not surprising that the industrial electrolysis of alkaline chlorides was first developed in Germany, which surpasses all other countries in deposits of rock salt and potassium chloride. The first impulse was given by a process patented by Hoepfner, in 1884, which, however, soon proved impracticable.

According to the chemical formula, a solution of sodium chloride (common salt) when electrolyzed, should yield sodium hydrate (caustic soda) and hydrogen at the cathode, and chlorine at the anode, but the reactions which take place at the electrodes were then little understood.

It was evident from the beginning that such staples as soda and chloride of lime could not be produced with profit on a small scale, but the employment of electrolysis, which is proportional to the area of the electrodes and cannot be effected economically with any but an exceedingly small current density, necessitated great enlargement of the already extensive plants. In order to make the apparatus as compact as possible vertical electrodes and porous diaphragms were employed. Breuer devised a diaphragm of cement, impregnated with salt and hydrochloric acid which, after some improvement, proved sufficiently resistant to the action of chlorine and alkalies. Iron and carbon appeared to be the most suitable materials for the cathode and the anode, respectively. It was found, however, that the water of the solution was electrolyzed with increasing rapidity as the process continued, and that the oxygen thus liberated gradually consumed the carbon anodes, producing carbon dioxide which became mixed with the chlorine. For this reason anodes of oxide of iron have lately come into use. These anodes are good conductors and last indefinitely, as they are not attacked by the oxygen, which at the high temperature of the bath (160-175 deg. F.) converts some of the sodium chloride into chlorate, which crystallizes in the anode compartment and is removed from time to time. Thus a valuable by-product is produced instead of the annoying carbon dioxide.

When the liquid surrounding the cathode has attained a certain degree of alkalinity, the circuit is broken and the alkaline liquid is drawn off and replaced by fresh chloride solution. The liquid in the anode compartment is not changed. The alkaline liquor is concentrated to half its volume in vacuum pans. Nearly all of the chloride which has not been decomposed is precipitated during this operation and is used again.

The first electrolytic plant established in Griesheim was operated with 400 horse-power. The capacity was doubled in 1892, and a factory employing 2,000 horse-power was started soon afterward. At the same time a 3,500 horse-power plant was installed at Bitterfeld. The Griesheim company also established a factory in France and one in Spain, the latter being operated by water power. The Baden aniline and soda company adopted the Griesheim process, which yielded chlorine and caustic soda, both of which were used in the production of artificial indigo. Another German and a Russian soda factory employ the same process.

Meanwhile the Elektron company, which owned Hoepfner's first patent, had consolidated with the Griesheim company, forming the Griesheim-Elektron Company, with a capital of $2,250,000.

In 1894 a 3,000 horse-power plant for the electrolysis of alkaline chlorides by the Ratheran process was built at Bitterfeld by the Allgemeine Elektrizitaets Gesellschaft, which subsequently established a 3,500 horse-power plant in Baden. The Griesheim process is now employed in factories with an aggregate consumption of 33,000 horse-power corresponding to a total annual production of 50,000 tons of caustic soda and 120,000 tons of chloride of lime.

This is not the only method by which the problem of electrolysis has been solved but the mercury processes of Castner, Kellner, and Solvay, and the Austrian "bell" process were not successfully employed until 1897 and 1901, respectively seven and eleven years later than the Griesheim process.

In all diaphragm processes the waste of current caused by the gradual accumulation of alkali makes it necessary to stop the operation before the alkaline solution has acquired great concentration. This defect led an American, H. Y. Castner, to suppress the diaphragm and use a cathode of mercury, which immediately amalgamates with the sodium liberated by electrolysis and prevents the decomposition of water. The accumulation of sodium at the cathode is prevented by causing the liquid amalgam to escape, as it is formed, to another compartment, where it is decomposed by water. Similar processes were devised by the Austrian Kellner and the Belgian Solvay, and all three mercury processes are now owned by the Castner-Kellner Alkali Company which was organized in 1895, with a capital of $1,500,000. This company and affiliated companies in Europe employ more than 6,000 horse-power, and the American Castner Company, of Niagara Falls, used 6,000 horse-power in 1901.

The mercury process possesses the advantages of dispensing with diaphragms, producing directly pure and strong alkaline solutions and thus saving expense in concentration, economical use of current and preservation of the anode, owing to the absence of oxygen. On the other hand, it possesses some great disadvantages, especially the higher voltage required (4.3 volts instead of the 3.5 volts of the diaphragm process), technical difficulties caused by the use of mercury and moving parts, and increased cost of plant. A 6,000 horse-power plant requires 72 tons of mercury, costing $90,000.

The Austrian "bell" process was designed to combine the advantages of both its predecessors and avoid their defects.

It employs, instead of mercury or diaphragms, the difference in density between the light anode liquid and the heavy alkaline solution which surrounds the cathode. This process is used in one establishment in Bohemia and two in Germany, but it has the disadvantage of requiring very complicated and extensive apparatus. The Bohemian establishment, of 3,000 horse-power, contains 25,000 "bells," or cells.

In order to trace the influence of electrolytic methods on the production of soda and chlorine, a brief sketch of the history of those industries is required.

In 1790 the French physician Leblanc, the father of chemical manufactures, won the prize offered by the French Academy for a method of obtaining soda from salt. For a hundred years most of the soda and other alkalies and nearly all of the chlorine and hydrochloric acid used in the world were produced by the Leblanc process. During the French revolution Leblanc's patent was revoked, his factory closed, its contents sold and the proceeds turned into the public treasury. The impoverished and heart-broken inventor ended his life with a pistol shot in his ruined factory in 1806. In the same year two new establishments for the production of soda by Leblanc's process were started in France, and others soon followed. The process was introduced in England in 1814, but was not greatly developed until the enormous tax on salt was removed in 1823.

In Germany the manufacture of soda by the Leblanc process commenced in 1843, and several factories were soon in operation. The process was adopted in the Griesheim chemical factory, which was founded in 1856.

An important characteristic of the Leblanc process is the production of a quantity of hydrochloric acid sufficient to neutralize all the soda produced. The acid remained largely a very annoying waste product until the demand for it was greatly increased by the general development of chemical manufactures, and especially by the sudden use of the aniline dye industry and the introduction of the Deacon and Weldon process of producing chloride of lime, about the year 1870.

The residue, containing sulphur in combination with sodium, constituted another troublesome by-product until methods of extracting the sulphur were devised.

The Leblanc process encountered no serious opposition until 1875, when Ernest Solvay introduced the ammonia soda process, based on the insolubility of ammonium chloride in solutions of salt. Then began a competition which in a few years reduced the price of soda by one half. In Germany, between 1877 and 1894, the annual production of soda by the Solvay ammonia process rose to 210,000 tons, four or five times the production of Leblanc soda. In England in the same period the annual production of the ammonia process increased to 280,000 tons, and a similar development took place in France, Belgium, and other countries. The total annual production of soda by the ammonia process amounted to 900,000 tons in 1900, 1,600,000 tons in 1903, and now exceeds 2,000,000 tons.

The advantages of the ammonia process over the Leblanc process consist of the employment of lower temperatures, with resultant economy of fuel, in lessened cost of labor and repairs, and especially in the possibility of employing cheaper raw material, namely, the crude lime as it is pumped from salt springs and mines, instead of rock salt or salt crystallized by evaporation. On the other hand, the Solvay ammonia process possesses the inherent defect that it utilizes only the sodium of the salt and throws away, in the form of a worthless solution of calcium chloride, the chlorine, which the Leblanc process delivers in the valuable form of hydrochloric acid.

Hence the once despised hydrochloric acid became the preserver of the Leblanc process. As the price of soda fell the soda manufacturers became dependent on the sale of hydrochloric acid, which assumed the position of the chief product. A large proportion of the sodium sulphate produced concurrently with the hydrochloric acid, in the first part of the Leblanc process (the decomposition of salt by sulphuric acid) was not converted into soda, but was sold to glass makers, who had found the sulphate a cheap and satisfactory substitute for the carbonate.

The introduction of the Griesheim electrolytic process profoundly affected both the soda and the chlorine market. In 1890 German imports of chloride of lime exceeded exports by nearly 7,000 tons, but in 1900 the exports exceeded the imports by 30,000 tons. The world's annual production of chloride of lime is now about 300,000 tons, of which about one third is produced by the Griesheim process and one sixth by other electrolytic processes. The remaining half of the total is still produced by the Deacon-Weldon process, which employs hydrochloric acid obtained, together with sodium sulphate, in the first stage of the Leblanc soda process. But only a small proportion of the sulphate is now converted into soda. The sulphate is not only used largely in glass making, but much of it is converted into sodium sulphide, which is used in the manufacture of sulphur dyes and artificial silk. Almost all the German Leblanc establishments have ceased to produce soda.

The effect of the electrolytic process on the alkali market was first felt in connection with caustic potash, which is chiefly used in soapmaking. The soapmakers soon found it more profitable to use the strong and pure electrolytic lye than to convert the carbonate into the hydrate, and concentrate the latter with small, imperfect and wasteful apparatus. In 1894 caustic potash was still imported into Germany, but 25,000 tons were exported in 1904.

The further development of the electrolytic process depends chiefly on the chlorine market as, though the demand for caustic potash is comparatively small, the market for caustic soda is unlimited. Since the introduction of the new process, a new market for chlorine has been found in the manufacture of various organic compounds, including chloroform, chloral, carbon tetrachloride, and chloracetic acid, which is used in large quantities in making artificial indigo. Chlorine, obtained by the electrolysis of salt, is now liquefied and shipped to manufacturers of chloride of lime and other products, not only in steel cylinders, but in tank cars of several tons capacity.

The great theoretical expenditure of energy, combined with the still imperfect utilization of current, in the electrolytic production of chlorates, restrict the employment of this method chiefly to districts possessing cheap water power, especially in France, Switzerland, Norway, Finland, and at Niagara Falls in America.

The latest commercial product obtained by the electrolysis of salt is hydrogen, which at first was allowed to escape but is now, though only to a small extent, compressed in steel cylinders under a pressure of 150 atmospheres, and sold for filling balloons and for use in the oxyhydrogen blowpipe for welding and cutting metals. Almost all German dirigible balloons have been inflated with hydrogen produced by the Griesheim electrolytic process.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

The plans for the proposed underground postal railway in Vienna are now under consideration, says Electrical Engineering. This railway will, if constructed, connect up the chief post office with sixty-four substations and nine railway stations in the city. Letters, newspapers, and parcels will be carried on trains of eight cars, running every twenty minutes. The trains will carry no motorman, but will be operated from the stations, and will travel at a speed of about 20 miles per hour.

NEW GAS FUSION PROCESS.

A GERMAN IMPROVEMENT ON THE OXYHYDRIC PROCESS.

BY CHARLES R. KING.

PROCESSES employing such gases as acetylene or oxygen for the fusion of moderate thicknesses of metal have been in use for years for the soldering or welding of joints or the repair of defective or broken pieces, and have recently received especial literary attention under the important title of autogenous welding.

In France, where the process is merely termed "blow-pipe brazing"—braze indicating a local melt over a brazier or hearth—the method has for a considerable time been found to be very convenient, in locomotive shops, for fusing together the thin metal sheathing or clothing of boilers, which, not being lagged with non-conducting materials, should be hermetic in order to make a perfect hot-air jacketing around the boiler and smokebox, and for joining the flue tubes of boilers, repairing superficial defects in locomotive frames, mending brakes in the liners of piston-valve chests and for a quantity of small work in which the joint by simple fusion is permissible, without compromising the strength of the rolled, cast or forged metal to which the process may be applied. For flue tubes, the oxyhydric fusing process is found to make a very tough joint, the flue breaking anywhere but at the jointed part; and it is very cheap and much more convenient than is the case even with model tube-welding plants, such as exist, for instance, in the locomotive works of the Saxon state railways near Dresden; but beyond a thickness of three millimeters the oxyacetylenic is found—on the Northern France Railway—to be the cheaper, although as regards the details of operation, the latter is more trying to the eyes of the operators; but both these gas fusing processes are found to be dearer than furnace work when the metal has to be fused to a depth of several inches.

In the oxyhydric gas fusing processes, the heat is furnished by the combustion of the hydrogen and resides in its flame; when applied to thin plates it rapidly penetrates the metal to the point of fusion; as, however, the thickness of the plates increases the heat penetration becomes rapidly slower, the heat of the flame spreading itself without effect through the mass of the metal and then being given off from the latter by the effect of irradiation. The limitations of the processes in use have given rise to another blow-pipe system embodying quite a different principle and suitable for fusing large masses of metal under conditions peculiar to the needs of large ironworks, such, for instance, as unchoking the tap hole of furnaces stopped up with cooled metal and usually necessitating a slow and difficult work of clearance with the aid of steel bars, sometimes, too, at a critical moment.

The new fusion process has been introduced by the Koeln Muesener Bergwerks Aktien Verein, and has been in successful use for the past few years. In operation the mass of iron to be treated has first to be heated yellow, high-pressure oxygen is then discharged against it so producing combustion of the particles of the iron itself which, being fused, is driven away by the high pressure blast of the hydrogen. Once the point of fusion is attained the heat is communicated with extraordinary rapidity to the rest of the metal in line with the blast. It will be perceived, therefore, that although the gas employed is the same as that which is used in the so-called welding process, it is the gas in the latter that acts as the combustible, whereas in the former it is the metal to be melted, usually iron, that constitutes the fuel. The difference in the application may be understood from a consideration of the fact that one kilogramme (2.2 pounds) of hydrogen develops by its combustion as much as 28,700 calories (one calorie=2.2 B. T. U.), whereas one kilogramme of iron develops only 1,640 calories.

On the other hand, one kilogramme of hydrogen occupies a volume of 11.116 liters (one liter is 61 cubic inches or 1.76 pint), whereas the volume of one kilogramme of iron is only 0.128 liter. It follows that the heat developed by one liter of hydrogen is equal to 2.58 calories while for the same volume of iron it is 12,900 calories. In other words, for a given volume the heat of combustion is 5,000 times greater for iron than for hydrogen. Besides this, the heat evolved by the combustion of 1 kilogramme of iron suffices to provoke the fusion of 4.4 more kilogrammes of this metal by reason of the rapidity, before mentioned, of the propagation of the heat through the iron particles neighboring the focus of the combustion, and these latter are driven off by the blast before they can be cooled by the irradiation of their heat, this being proved by the fact that masses of iron pierced by the blast, and fused inside, remain cold enough on their outside surfaces as to allow the latter to be touched by the hand. It is precisely this peculiarity which renders the process of value for piercing or cutting large masses of metal without affecting adjoining parts outside of the line of the blast. Thus, the choked tap-holes of blast or steel furnaces may be melted out without danger to the lining, and even the tuyeres, blocked with metal, can be melted out, the iron inside them being fused while the tuyeres themselves retain a relatively low temperature. Here, the fused metal is blown off immediately by the pressure of the blast, or hydrogen blow-pipe, while the surface of the tuyers is impinged continually with the cold oxygen blast.

Besides being especially valuable in emergency cases such as those which occur in blast furnace work, where any delay may endanger the life of a furnace, the process is of particular use in steel works and rolling mills. Running holes of steel furnaces are opened by it with rapidity and Martin furnaces and steel pockets are emptied promptly without any loss in the quality of the steel, from its being kept too long in the furnace, or without destruction of the steel pockets. It is used in place of costly mechanical operations for the dismounting of pieces that have become rigidly attached together by long contact: as foundation bolts, shaft couplings, etc., and wherein a local melt expeditiously solves some difficulty which can only be otherwise overcome by long and tedious mechanical means. Already the process is employed in a considerable number of German metallurgical works, the results being really surprising, especially when a battery of hydrogen blow-pipes is available with nozzles bent and curved in such a way as to enable the fusing operations to be effected in all directions to suit various contours.

The Koeln Muesener apparatus consists essentially of a blowpipe having, as in the oxyhydric welding blowpipe, two concentric tubes. Oxygen under pressure is delivered into the inside pipe, while the outside tube serves for ordinary lighting gas, under pressure for starting the action of combustion, after which the coal gas is cut off. The entire apparatus consists of:

1. A cylinder of oxygen compressed to 125 atm. pressure.
2. A pressure-reducer fitted with two gages indicating, one the pressure in cylinder, and the other the reduced pressure; and also a safety valve.
3. A flexible metallic pipe conveying oxygen at 30 atm. pressure to the inner tube of the blowpipe.
4. A cylinder of lighting-gas compressed to 200 atm. pressure.
5. A gas pressure regulator identical with that for the oxygen and likewise fitted with two gages and a safety valve.
6. A rubber pipe conveying lighting-gas to the outer tube of the blowpipe.
7. A blowpipe arranged as already mentioned. Differing from the oxyhydric blowpipe, or "torch," the two gases do not intermix before combustion, the hydrogen tube being carried to the nozzle extremity of the blowpipe. The inner tube is maintained in the center of the gaspipe by means of small adjusting screws.
8. A series of carbon rings fitting the nozzle of the blowpipe and protecting its metal from the surrounding heat.

To use the apparatus the gas in the outside pipe is turned on and lighted. The oxygen is then turned on. The metal to be melted having been first heated up to near upon the degree of heat of combustion of its constituent elements, the lighted blowpipe is then directed on the mass until the combustion of it is started—when the coal gas can be cut off. The time taken to fuse a mass of metal depends upon the thickness to pierce. A case may be mentioned of a cylinder of steel, 10 inches long, which was pierced by this method in less than a minute. The piece had not been previously heated for the operation, and the diameter of the bore thus made was about 3 inches.

For those who know the limitations of the oxyhydric or oxyacetylenic process, this example will serve to indicate the large difference of these compared with the Koeln Muesener system, and above all when it is considered that the oxyhydric flame attains a temperature of 2000 deg. C.; and that, on the other hand, the oxygen by its expansion cools at 10 deg. C.

The consumption of oxygen, according to the formula $3F.+4O=Fe_3O_4$, is 380 grammes, or 240 liters, of oxygen to melt 5.5 kilogrammes of iron, reckoning that 1 kilogramme of iron furnishes by its combustion the heat necessary to melt 4.4 additional kilogrammes.

The oxygen is sold commercially in special cylinders, costing, in Germany, the equal of 3/3 for one cubic meter (35.3 cubic feet).

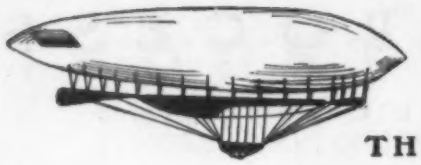
The economy of the process is necessarily the greater where the price for hand or mechanical work is high. In Germany such work is moderately priced and yet the saving is found to be considerable. The cost of melting out the tap hole of a blast furnace is found to be 4s. 2d. to 5s., reaching in the worst cases to 8s. 4d. In the case of emergencies the process is found to be invaluable, the mere cost of gas being then immaterial. The consumption of coal gas is very little because it is only used in starting the apparatus.

DEPTH OF THE GULF STREAM.

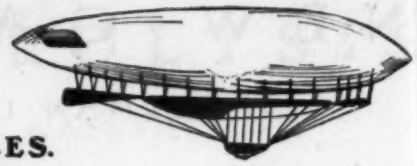
IN Lieut. Pillsbury's examination of the Gulf Stream at various points from Hatteras southward, he found that the stream reaches to the very bottom in some places and tabulated its velocity at different depths. His results, as well as a review of the whole field of Gulf Stream investigation, are found in appendix 10, report for 1890, of the United States Coast and Geodetic Survey. It must not be inferred from the foregoing that all ocean currents extend to the bottom of the sea. Many instances are at hand of ocean currents extending to great depths. For example, Admiral Erminger, of the Danish navy, found that the northwesterly current in latitude 25 deg. 04 min. N., longitude 65 deg. 41 min. W., prevailed to a depth of 200 meters; Commander John R. Bartlett, United States navy, found a current in the Windward Passage to the depth of more than 800 fathoms (1,460 meters), and concluded that it reached to the bottom; between Key West and Havana the stream was measured in 1860 to a depth of 600 fathoms (nearly 1,100 meters), and was found to be only 10 per cent less than at the surface.

It is well established that the Gulf Stream loses in depth, temperature, and velocity, and gains in width, especially after passing Cape Hatteras, until the 40th meridian it becomes a drift current, reinforced on its right flank by the powerful Bahama current. Various measurements for temperature show that the Gulf Stream is shallower than its northeastern extension beyond the 40th meridian. Thus, Commander Chimmo, R. N., commanding H. B. M. S. "Gannet," during the summer of 1868, found the warm water of the Gulf Stream to be less than 50 fathoms deep in latitude 44 deg. 03 min. N., longitude 48 deg. 07 min. W. Ten degrees to the eastward the warm water had deepened to 100 fathoms or more and in latitude 43 deg. 43 min. N., longitude 37 deg. 47 min. W., the warm water was found to extend down about 250 fathoms. Observations made on board H. B. M. S. "Porcupine," during the summer of 1869, showed remarkable depths in the Gulf Stream drift, as follows: In latitude 59 deg. 35 min. N., longitude 9 deg. 11 min. W., the warm water was found to extend to the very bottom of the sea, 767 fathoms (1,400 meters); at Rockall the warm drift was found to reach down 900 fathoms below the surface, and similarly again in latitude 47 deg. 38 min. N., longitude 12 deg. 08 min. W. At the last-mentioned observation spots the warm water was found to be underrun by a polar current at a depth of more than 900 fathoms. A similar phenomenon is often observed near the Grand Banks where the Labrador current dips under the Gulf Stream at comparatively shallow depths, 50 to 100 fathoms.

The Production of Transfer Pictures.—Smooth, unsized paper, not too thick, is coated with the following solutions: 1. Gelatine 10 parts in 300 parts of warm water, applied with a soft sponge, laid flat and left to dry. 2. Starch 50 parts, gum tragacanth 10 parts, in 600 parts of water (the gum tragacanth is dissolved in 300 parts of the water, in the other 300 parts the starch is boiled into a paste in the usual manner). Dried sheets are painted with the tragacanth paste thickly but uniformly and allowed to dry again. 3. Blood albumen 1 part, soaked in 3 parts of water for 24 hours with small addition of spirits of sal ammoniac. The sheets must be coated with these solutions and dried after each application. Print with ordinary colors, but in reverse order.



GERMAN AIRSHIP SHEDS.



THE PROBLEM OF HOUSING DIRIGIBLES.

BY OUR GERMAN AERONAUTIC CORRESPONDENT.

ONE of the most important questions in connection with aerial navigation is the providing of suitable places of refuge for the enormous dirigible balloons of which Germany is the proud possessor, and the final settlement of the question is rendered still more difficult by the fact that, as regards the rigid types, dirigibles of much larger dimensions than those already existing have been devised, and are now in course of construction, so that it is hard to say when and where the limit will be reached.

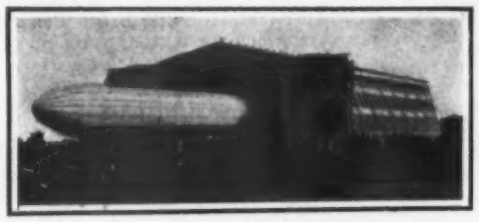


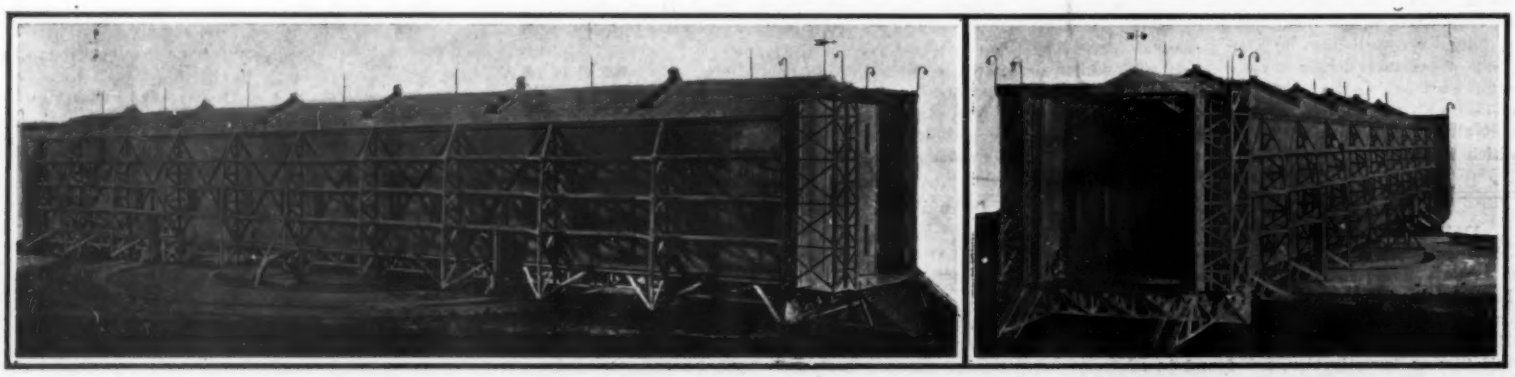
FIG. 1.—ZEPPELIN AIRSHIP EMERGING FROM THE SHED AT METZ.

FIG. 2.—THE ZEPPELIN STARTING ON A JOURNEY.

FIG. 3.—DESIGN OF A ROUND SHED MAKING POSSIBLE THE EMERGENCE OF THE AIRSHIP AGAINST ANY WIND IRRESPECTIVE OF ITS DIRECTION.

The first permanent shed of large dimensions in Germany—except, of course, the floating one built on Lake Constance by Zeppelin when he commenced to build the first "monster," is that erected at Metz for the military station by L. Bernhard of Berlin. The shed in question is 150 meters (492 feet) long, 40 meters (131 feet) wide, and 31 meters (102 feet) high. It is calculated to hold two Zeppelin airships or four Gross or Parsevals. At present it harbors one Zeppelin, one Parseval, and one Gross. It is an iron construction with walls of iron, and wooden roof, with tar-paper insulation. It has proved practical to have the walls constructed of corrugated iron in a building of such large dimensions, where the corrugated metal does not act as a good conductor of heat, so that a constant temperature is maintained at a cheap cost. The door consists of two sliding panels of corrugated iron, each having a surface of 20,125 square meters (216,626 square feet). They are moved by a windlass on each side, each of which is operated by two men. Ten minutes is necessary in which to open or shut them. Our illustrations, Figs. 1 and 2, give a good idea of the comparative size of the Zeppelin airship and the above mentioned shed. Such an oblong shed is not of the type which was desired by the Zeppelin Company, which has strongly urged the government to provide round construction even in the case of the smaller dirigibles of the non-rigid or semi-rigid types, it is difficult and dangerous to bring one out of its shed with the wind blowing sideways or direct into the entrance. This was shown upon one occasion at the last aeronautical exhibition at Frankfort, when the envelope of the "Parseval" was badly ripped by being jammed against the door posts as the airship was being brought out in the face of a moderate breeze.

Fig. 3 shows a round construction designed by J. Genz, of Oberhausen, which was shown in model at the Frankfort exhibition. As will be seen, it is provided with entrances on all sides, and was specially designed to fill the requirements of the Zeppelin Company; but naturally the cost of such a construction is so much greater than the usual oblong buildings, that the German government has not yet seen its way clear toward complying with the demands of the Zeppelin Airship Company. The floating shed on Lake Constance is also an oblong building, but as it is anchored at one end only the wind always floats it into position, so that a round hall was not necessary. On *terra firma*, where the greater part of the sheds are to be erected, the turning round of a building of at least 150 yards in length is a somewhat more complicated affair. Photographs Nos. 4 and 5 show front and side views of an interesting solution designed by A. Klonne, of Dortmund, which the firm offers to build, up to the following dimensions: Length, 150 meters (492 feet); inside width and height, 25 meters (82 feet). The building is supported on wheels running on a rail so far removed, that comparatively little effort is needed to bring the entrance round to the lee side. In this way almost the same effect is reached as in the floating Zeppelin shed on Lake Constance, while the letting out of the water causes the building to rest firmly on the supporting rail again. A sail placed longitudinally along one end of the shed is sufficient to bring it into position when a moderate wind is blowing; otherwise it can easily be moved by hand, machinery, horse or motor car. The building is just sufficiently lighted by means of windows and skylights, but not so extensively as to allow the rays of the sun to affect the dirigible it harbors. Ample provision is also made for ventilation and the removal of diffused gas. The roof and walls are covered by an asbestos mixture, selected on account of its light weight and its good insulating qualities. The construction of the door is clearly shown in the illustrations. It is of the folding type operated by sprocket wheels and rail at the top and bottom, and when folded back fits into a latticed casement, as shown in the illustration.



FIGS. 4 AND 5.—SIDE AND END VIEWS OF THE KLONNE REVOLVING AIRSHIP SHED, WHICH IS MOUNTED ON FLOATS IN A CIRCULAR TANK.

TYPES OF GERMAN AIRSHIP SHEDS.

Another model is shown in Figs. 6, 7, and 8. This is of the non-revolving type, but has the advantage that it can be enlarged in length and height without in any way disturbing the previous construction. Besides this, no scaffolding is needed in its erection, and it can be put up on the most uneven ground. At a test a construction measuring in length 100 yards, in width 50 yards, and in height 25 yards, was put up in 36 hours. Fig. 6 shows a model erected at

the Frankfort exhibition with the canvas covering removed, in order to show the construction of the supporting walls, which consist of a series of iron frames and rails. The frames, with the exception of the end ones, are interchangeable, as are also the connecting rails. A row of frames is connected together by the joining rails to the required length of the shed and successive rows are built up till the

FIG. 6.—MODEL OF A SECTIONAL AIRSHIP SHED EXHIBITED AT THE FRANKFORT AERONAUTICAL EXPOSITION.

required height is reached, whereby the framework itself takes the place of scaffolding. Each frame in the original construction is 2 meters (6½ feet) high and 1½ meters (5 feet) wide, and weighs about 130 pounds. They are strengthened by diagonal and transverse pieces, and the connecting rails to the frames, which are 3 meters (9.8 feet) long, are fastened by studs and keyhole shaped orifices, screw bolts and nuts being used for fastening two frames together.

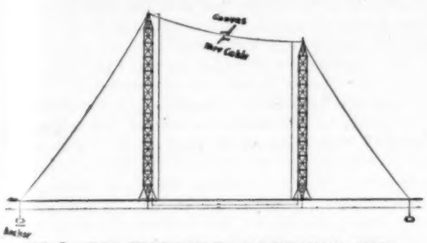


FIG. 7.—END ELEVATION OF SECTIONAL SHED, SHOWING FRAMES ASSEMBLED.

Fig. 9 shows a model of wooden construction, designed by the Deutsche Scheunen und Hallenblau Gesellschaft for the Rheinisch-Westfaelische Airship Company of Elberfeld. This shed was erected at Leichlingen, near Cologne. The details of construction will be seen from Fig. 4. It is of wood covered with 1-inch boards, with tar-paper insulation. The floor is of oil-resisting asphaltum. Its cost, inclusive of the offices, workshops, and all other accessory compartments, is about 18,000 marks ($4,295).

Fig. 10 shows a model fire-proof construction of reinforced concrete designed by Dickerhof & Widmann, of Karlsruhe.

It has also been proposed—as a means of avoiding

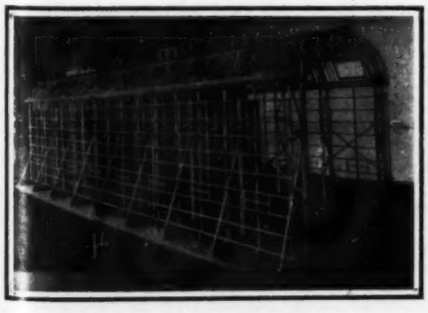


FIG. 9.—MODEL OF WOODEN SHED BUILT AT LEICHLINGEN FOR THE RHEINISCHE WESTPHALISCHE AIRSHIP COMPANY.

the cost of erecting large sheds—to dig out excavations in the earth, so as to form airship docks at any place necessary. Such an excavation can be provided with a sliding roof, and has the advantage that, in addition to the small cost, the airship does not have to be brought in through a narrow entrance, but can be drawn down from above by means of ropes running on rollers at the bottom of the trench. Fig. 11 shows diagrammatically such a dock, which was described by the inventor, F. W. Olges, some time ago, in SUPPLEMENT No. 1733. A complete description of the revolving shed, with diagrams, will also be found in SUPPLEMENT No. 1749.

BRAKE SHOE OPPORTUNITY.

MR. WILLIAM WHITTAM, Jr., formerly a special agent of the Department of Commerce and Labor, offers suggestions for the introduction into Great Britain of the quickly exchanged brake shoes made in the United States. As to their usefulness he writes: Railroads in the United States have neglected no opportunity to secure every means for economizing in rolling stock. The good and effective work done by their Master Car Builders' Association can not be overlooked. With active committees that watch closely development of every kind, supported by the manufacturers of railway material, who specialize in every direction, they

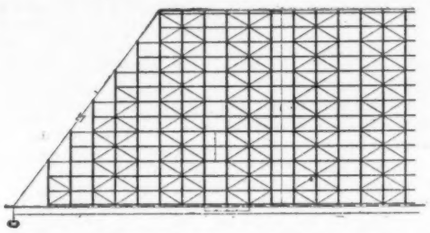


FIG. 8.—SIDE ELEVATION OF SECTIONAL SHED, SHOWING CONNECTING RAILS OF THE FRAMES.

have largely succeeded in bringing about a much-desired reduction in the annual expenditures of railroads. Concentration of efforts have established standards for material. The ever-increasing speeds and loads on railways necessitated a thorough investigation of the brake-shoe equipment, for which millions of dollars are annually expended. In this feature a splendid system has been developed, its simplicity showing at a glance its advantages, of which I recently witnessed a striking illustration. An engineer on one of the largest railways in the States was just about ready to pull out of the yard. Before doing so, he once more made an examination of his engine to make certain that everything was in running order. Happening to glance at one of the brake shoes on the drivers of his locomotive and seeing that it was nearly worn to the limit, he decided to replace it by a new one. Although there was scarcely a minute's time to spare, he accomplished the change in even half the time. This fact, and a scrutinizing of the worn-out brake shoe he threw away, which was a mere shell, aroused my interest in the brake-shoe industry. Obtaining an introduction to the manufacturers of this material, I found that the manufacture of their product, as well as of their means of providing railways with brake shoes especially suited for the conditions of the various services, was of considerable magnitude. The output of one of the manufacturing plants was close to 125 tons per day. A careful study of the iron used in their product is made in a well-equipped laboratory. There are special departments which cover certain requirements in the production of these shoes and which have minute attention in order to furnish the railroads with the best brake-shoe material at the lowest cost, which is fully appreciated and recognized among American railroad interests.

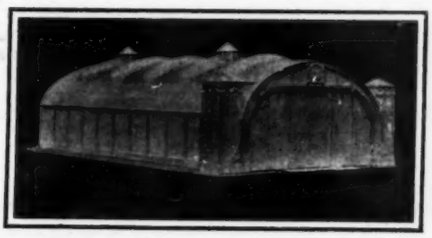


FIG. 10.—MODEL OF A FIREPROOF AIRSHIP SHED OF REINFORCED CONCRETE.

The time taken in replacing a worn-out brake shoe in the United States is only a part of a minute, while the changing of a brake in Europe takes many minutes. Altogether, there would seem to be an excellent opening for American enterprise in this direction. It is clear that a wonderful opportunity exists in Great Britain and Europe for the export of the American type of brake shoe. In Europe the solid shoe is common, but this type became practically obsolete in the United States many years ago. With this solid shoe a waste of 15 to 20 pounds of material occurs, against a "scrapping" of but 6 to 7 pounds on the American plan.

The hilly territory of Trieste, it is stated in a consular report on that district, is covered by pointed stones which prevent any cultivation, and some years ago the Società Agraria offered prizes for those who would remove them and thus change the waste ground to meadows. The work has now been going on for some years, and every autumn a commission ascertains the area of the proposed redemption and the difficulties to be encountered, and fixes the prize to be given. In spring it again visits the improved grounds and pays the prizes if deserved. This year in the different parishes 66 peasants improved 44 acres.

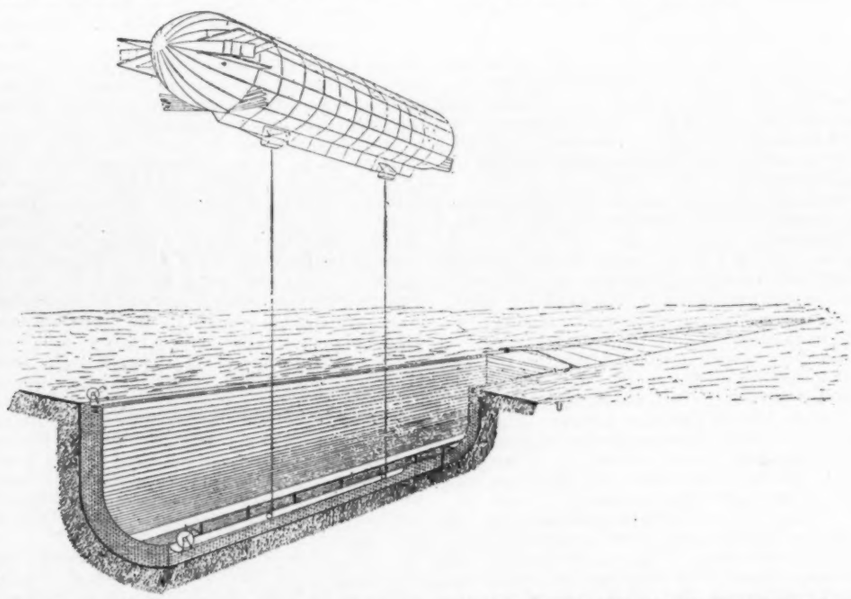


FIG. 11.—AN AIRSHIP HARBOR CONSISTING OF A TRENCH INTO WHICH THE AIRSHIP IS DRAWN FROM ABOVE. A COVER IS THEN SLID OVER IT.

TYPES OF GERMAN AIRSHIP SHEDS.

COFFEE AS A BEVERAGE.*

ITS USE AND ABUSE.

BY ROBERT AMORY, M.D.

THE writer of this article having noticed in a printed statement that Col. Younghusband advised the preparation of cold-water infusion of coffee as a beverage, to be taken during long outdoor journeys into the wild country of Thibet, was tempted to prepare coffee in the same way for home use. The result of experience, taken in connection with the investigation of the well-known composition of the coffee bean, seemed to show that the same method can also be greatly improved for domestic use over the usual preparation of making an infusion by the use of boiling water. A cup of coffee may be prepared by passing cold water through finely-ground coffee contained in a porcelain or china percolator, such as the Austrian coffee "biggin." This extracts only one-ninth of the bitter caffeine and one-fifth of the tannin contained in this bean. It will also preserve the aroma of the volatile oils contained in this bean. These advantages are so obvious that it is worth mentioning to those who are fond of coffee drinking, but who wish to reduce the unpleasant results, such as wakefulness, excitability, and disturbance of digestive processes, these conditions being largely due to the presence of caffeine and tannin, which are very much more soluble in boiling and hot water used in the ordinary preparation.

The writer has tested this method for a period of more than five years and is well satisfied with the experience. The following article is intended to show the difference between coffee made in the ordinary manner and that made by the "cold-water method," which it describes later.

It may be interesting to learn the experience of one who has spent a long life in studying methods of preparing coffee beverage in various forms, namely, with hot water, boiling water, and cold-water solutions for drinking. The errors of making coffee beverage should be viewed from the standpoint of its chemical and physical constituents. This article will begin with a description of these.

The coffee bean which is the product of cultivation in many tropical countries, is gathered and dried by the sun and exported to the various market centers, where it is used to a very large extent, at a distance from the country in which it is grown.

This coffee bean, as is well known, cannot be used to produce an agreeable coffee beverage unless it is roasted and carefully ground to a fine powder. It should, while roasting, be continually agitated in order to remove the loose particles of its envelope, taking pains to heat the ground bean equally throughout its interior.

Coffee bean contains, among other substances, caffeine, tannin, and the volatile oils; the latter give the aromatic flavor, which is stronger when the liquid coffee is hot. This aroma will be increased if the grinding of the bean is rapidly conducted, because the friction will set it free. These aromatic oils will be readily absorbed by cold water used in making an infusion.

The substance called caffeine is supposed to represent the active principle of coffee, and exists as a latent element in the coffee bean. When isolated it is a "white powder," having a slightly bitter taste and an acid reaction. At 77 deg. F. it is soluble in one-ninth of the amount of water required for its solution in hot water (175 deg. to 212 deg. F.). Its solubility is increased in water containing cerium salts, potassium, and sodium salts. These salts are usually contained in spring and well water (hard water).

It will thus be seen that caffeine at a high temperature will require 5.2 parts only of water for its solution, while at a low temperature it will require about nine times as much; and it will also be noticed that its solubility is increased by the presence of certain salts which are usually contained in spring and well water.

Caffeine when given as a medicine, separated from coffee, often causes headache, and in rare instances of susceptibility in the individual mild forms of delirium, noises in the ears, and flashes of light, showing derangement of hearing and eyesight. Caffeine, especially in the form of caffeine citrate, is used in some cases to relieve headache, though in other susceptible individuals it may increase it. Where the action of caffeine is not followed by disagreeable sensations, as before stated, its absorption is often followed by increased mental action, sometimes a period of depression, oftentime exhilaration, and in these cases interference with sleep. It has the peculiar action of exciting the muscles, and in susceptible people may produce irregular muscular contractions and tremors. It may also sometimes affect the pulsation of the heart, causing irregular action and interfere with the equable effect of circulation throughout the whole body.

Tannin (or tannic acid) is another ingredient of coffee bean. The Pharmacopœia (United States, 1900) states that it is soluble in cold water only to a slight degree, but very soluble in boiling water, and in its solution will turn blue litmus paper pink, showing its acid reaction.

In the vegetable kingdom tannin is found in the oakgall and in a very large number of other growths. Both tannin and gallic acid with iron solutions form an inky substance suspended in water, which is favored by heated water. The action of tannin when swallowed produces an astringent sensation in the mouth, throat, and gullet, and a disagreeable oppressed feeling in the stomach. Pure tannic acid appears in the form of a yellow-colored amorphous powder. It is used in medicine as an astringent, and produces a construction of the smaller blood vessels to relieve hemorrhage; also by its astringent action within the alimentary canal to relieve diarrhea.

The volatile oils, which are set free by heating the ground coffee, or by its infusion in boiling water, stimulate the interior surface of the stomach and bowels, and thus favor the digestion by increasing the peristaltic action of this part of the alimentary canal, especially in the primary stage of digestion.

Cushny states that "in the stomach tannic acid combines with any proteid substance with which it may come in contact, precipitating it, but as digestion progresses this combination is broken up, as the peptones do not combine with tannic acid in acid solution during the second stages of stomachal digestion, and the astringent action is, therefore, exercised on the walls of the stomach and intestines. Ordinary quantities cause the same superficial coagulation as in the mouth; but if large doses be given when the stomach and intestine are not protected by foodstuffs, a more complete coagulation of the mucous membrane takes place, and the consequent irritation results in vomiting and sometimes in diarrhea.

"The local application of tannic acid causes a diminution of the secretion of glands, as has been demonstrated by Schutz. This is due to its effects upon the protoplasm of the secreting cells, which probably undergo the initial stages of coagulation."

Another local effect produced by tannic acid is seen in the cessation of the movements of the leucocytes in the tissues around the point of application, and the arrest of their diapedesis through the walls of the vessels.

Cushny (p. 254) also states that "coffee is not used in medicine, but in view of its immense dietetic importance it may be mentioned here in what respects it differs from the pure caffeine. The coffee bean contains about two-thirds of one per cent caffeine, and the roasting does not seem to reduce this percentage at all, as was formerly supposed; and since almost all the caffeine is extracted by the ordinary hot culinary preparation, a cup of coffee contains 0.1 to 0.2 gramme (1½ to 3 grains) of caffeine. Along with the caffeine there are extracted a number of other substances, the most important of which are volatile substances produced by the roasting, which have been called caffeon, and resemble in their action the volatile oils.

"The wakefulness and the relief from fatigue which are produced by tea and coffee are undoubtedly due to the caffeine contained in them, and are to be ascribed to the central action chiefly; although the action on the muscles may also be of some value here. On the other hand, the feeling of well-being and comfort produced by coffee after a full meal is probably to be explained by the local action of volatile oils in the stomach. The same result is produced by preparations of the other volatile oils, and, in fact, these are often added to coffee in the form of brandy and other liquors. Apart from this local action, the volatile parts of tea and coffee (theon, caffeon) seem to have no effect whatever on the economy. In the experiments on the activity of the digestive ferments outside the body, it is found that caffeine increases slightly the rapidity of the process, but that coffee and tea retard it considerably. On the other hand, coffee, probably owing to the volatile oils, increases the peristaltic movements of the intestine, while caffeine has no effect on them. . . .

"It was formerly stated that coffee lessened the tissue changes and that it ought, therefore, to be included among foods, and one enthusiast even suggested that diet of tea and coffee exclusively should be served out in the besieged fortresses of France in 1870. It has been shown conclusively, however, that far from lessening the metabolism (organic interchange of tissue) of the body, coffee and tea increase it, the amount of urea and carbonic acid excreted being considerably augmented by their use. This is only to be expected from the increased activity of the nervous centers, which leads to increased movement and increased consumption."

Obviously, from the above review of the physical and chemical constituents of coffee, it will be observed that the beneficial effects of coffee beverage have a stimulant value upon the individual who drinks it. In order to avoid a deleterious, stimulating effect upon the body, caffeine and tannic acid should be excluded as far as possible from the cup of coffee, while as much as possible of the volatile oil should be included in it; coffee, therefore, should be taken with food, and not on a fasting stomach. After a full meal, or during it, coffee is beneficial to digestion, as may be gathered by the foregoing remarks. If brain and muscular stimulation are desired, it is much better to take caffeine, the exact dose of which may be limited. Again, it is obvious that the hot or boiling water used in preparing coffee beverage should be avoided, and the infusion of coffee should be made with cold water.

The writer of this article has for the last eight years prepared his coffee in a porcelain or china vessel with cold water, and has carried it away with him for two or three weeks at a time, during which it did not lose its color, strength, or aroma, if kept carefully corked in a cool place. He always prepared this infusion in a concentrated form, and just before drinking adds hot water, hot milk, or hot cream (all these heated to boiling point), with the result of setting free the volatile oils. This produces a delicious cup of fragrant coffee, which is free from the bitter taste of an excess of caffeine and tannin. In order to make an agreeable cup of coffee the following directions should be carefully observed: Grind the coffee rapidly to a fine powder, as the heat from rapid friction will excite the evolution of the volatile oils. It is important that the grinding should be done immediately before preparing the extract. If the ground coffee stands in the air, the volatile oils will evaporate. The coffee should be ground to an impalpable powder. Place the ground powder in the upper part of an Austrian china "biggin" (percolator), leaving off the cover and the small saucer; put in a lump of ice and pour on cold water from a water tap (not well or spring water), and let the ice-cold water drop through the ground coffee, stirring the mixture carefully and thoroughly into a paste-like mass. To facilitate the percolation of the infused water extract, it is advisable to place a small piece of wood between the lower edge of the receiver which contains the coffee grounds and the upper portion of the vessel which receives the infusion, as this leaves a little air space between these parts. When the liquid coffee infusion has all dripped through the percolator, pour back through the wet grounds all the liquid from the bottom receiver and allow the percolation to go through the same process as before, replenishing the ice if necessary. Now place the lower portion of the "biggin" in a cool place and put on the cover. It should be noticed that the result of this, unless too much water is used in the percolation, will produce a very strong extract. This is desirable, because in preparing it for the cup it is advisable to add sufficient boiling water to reduce it to the required strength, and the boiling water will set free the aromatic volatile oils which give the agreeable flavor.

The use of a metal "biggin" for preparing an infusion of coffee is entirely wrong for the following reason: The vegetable matter suspended in the liquid infusion collects in the angles of the bottom receiver and rapidly becomes the center of a decomposition, the result of which is accompanied by the development of micro-organisms which destroy the suspended particles left in the infusion, and these particles are what contain the agreeable taste of coffee. On the other hand, clean china or glass does not collect these micro-organisms to any positive degree, especially when the coffee is kept in a cold place. Indeed, if the hot coffee is placed in a corked bottle in a cold refrigerator, the rapid cooling of this liquid will so shrink its volume that the reduction of bulk will suck in the cork of the bottle. "Hard water" such as well or spring water should not be used in preparing coffee, because both of these contain salts in solution, as previously mentioned, which favor an increase

* Boston Medical and Surgical Journal.

in the proportion of the caffeine and tannin contained in the bean and would give it a bitter taste. In restaurants, coffee is often prepared in large metal vessels, provided with a method of heating by gas or electricity, so that it may be always kept hot and ready for use. This is one of the reasons why it has a charred taste. It would always be ready for use if made with cold water, and could easily be made hot by adding the boiling water when needed for use. If any of the readers of this article will try making coffee by the above method, the writer feels sure that they will never again make boiled coffee to drink.

METABOLIC ACTIVITY OF BEES.

HOW BEES UTILIZE OXYGEN.

ALL living creatures use oxygen during their life, and form carbon dioxide. Life depends upon this reaction. The magnitude of this metabolism of gas, i. e., respiration, is by no means equal in all animals in proportion to their weight. Small birds, for example, show a very high respiratory activity; cold-blooded animals, such as frogs and fishes, a very low one. The quantity of oxygen absorbed, also, does not necessarily correspond exactly to the carbon dioxide given off, since a formation of the latter gas can result from processes of decomposition in the blood, unaccompanied by consumption of oxygen. On the other hand, a part of the oxygen absorbed goes to form water. The ratio of the expired carbon dioxide to the oxygen absorbed at the same time is called the quotient of respiration.

It is of the highest interest, therefore, to ascertain the ratio of this gas metabolism in different kinds of animals, because there is thereby given, in various ways, an explanation for phenomena which are otherwise inexplicable. Marre Parhon has published (Annales des Sciences Naturalles) her searching, highly interesting investigation into the metabolism of bees during the four seasons of the year, in which she worked, on an average, with about 600 insects at one time.

The results of the experiments show that the respiratory gas metabolism in bees is exceptionally vigorous as compared with other animate creatures. A few figures may serve to illustrate this:

	Temperature, Degrees C.	Oxygen per Kg. and Hr. Ccm.	Carbon dioxide per Kg. and Hr. Ccm.	Quotient of Respiration $\frac{CO_2}{O_2}$
Bees	20	17,336	17,575	1.01
Flies	19	6,709	5,351	0.79
Flies	20	4,980	5,739	1.14
Dog	21	911	674	0.74
Chicken	19	740	675	0.90
Man	20	233	166	0.78
Lizard	20	134	100	0.75
Frog	20	70	57	0.80
Carp	8	55	37.5	0.66
Crab	12.5	38	33	0.86
Starfish	12.5	32	25	0.78

The figures given here for bees are those which the authoress obtained in summer, and while the bees were exposed to a temperature of 20 deg. Experiments carried out under the same conditions (20 deg.) gave in spring 29,754 cubic centimeters of oxygen and 30,408 cubic centimeters of carbon dioxide, in fall 24,795 cubic centimeters of oxygen and 25,881 cubic centimeters of carbon dioxide, and in winter 22,549 cubic centimeters of oxygen and 23,038 cubic centimeters of carbon dioxide. The maximum of respiration occurs, therefore, under this condition (20 deg.) in the spring, the minimum in summer. For other temperatures the results were as follows:

10 deg. maximum in summer, minimum in winter.
32 deg. maximum in fall, minimum in summer.
35 deg. maximum in fall, minimum in summer.

In spring, fall, and winter the maximum of gas metabolism is not at 10 deg. but rather at 20 deg. In winter the exchange of gas stops almost entirely at 10 deg., and the cold causes the bees to speedily become torpid.

It appears from this that the exchange of gas in bees varies indeed with the temperature of their environment, but that the changes thereof do not occur in the same manner as is the case with cold-blooded animals. The bees have, within certain limits, the ability to regulate their temperature and resemble therein the warm-blooded animals. While with the latter, however, the increase of gas metabolism proceeds as far as very low temperatures, a stop occurs with bees at 10 deg. or 20 deg. In the struggle against cold the warm-blooded animals are better equipped; not so, however, in the struggle against heat. For the latter the warm-blooded animals have only one means —an increase in the loss of heat; bees possess in addition thereto the means of reducing the production of heat by abatement of respiration.

Measurements of temperature show that the heat produced in the different parts of the year is paralleled by metabolism of gas, as a rule.

The vigorous respiration of the bees is explained by the diversity of their activities, which is a result of their gregarious life. Since the nature of these activities and the exterior temperatures is different for each season of the year, the gas exchange cannot remain the same during the entire year. It varies with the season of the year and within the same season with the temperature of the environment, in that it increases (within certain limits) when the temperature falls, and conversely. The struggle of the bees' organization against the change of temperature of the environment is particularly noticeable during the transition periods of the year, i. e., spring and fall. At 20 deg., for example, bees consume in summer 17 liters of oxygen per kilogramme an hour, in fall 24 liters; at 32 deg., 11 liters in summer, and 17 liters in fall. As an aid to the comprehension of this ratio, the authoress calls attention to the fact that upon entering a subterranean chamber (of a constant temperature) we experience a feeling of warmth in winter but of cold in summer, since our peripheral nervous system accommodates itself in the different seasons of the year to different temperatures. Similarly, the bees, since they are for the most part in the open during the summer, and therefore at an average temperature of 20 deg., are accustomed to this temperature, but in fall and winter, on the other hand, when they are in the hive at a temperature of 32 deg., they are accustomed to this higher temperature. When they are thereafter brought to a temperature of 20 deg. in a subsequent season of the year, they experience a lower temperature, and react therefrom by increasing the metabolism of gas. The noteworthy elevation of the gas metabolism in spring (34 liters of oxygen) can, however, not be attributed alone to the struggle against the cold; here the return to the activities of summer operate as a provocation.

The bees strive against the cold, however, not only by increasing the production of heat, but also by decreasing the loss thereof. Among the causes for the abstraction of heat from living organisms, perspiration is one of the most important. Experiments have shown that the loss of water from the bodies of bees is much less in winter than in summer. By retaining water in their tissues during the cold seasons of the year, the bees save the heat necessary for the evaporation of that quantity of water. They strive in a similar manner against the heat, in addition to decreasing combustion, by also separating a greater quantity of water.

The quotient of respiration varies very little from one season of the year to the other. It oscillates, generally, about unity, but is often equal to 1. This quotient of respiration is proof of an alimentary process rich in carbo-hydrates. Now honey, which is the most valuable nourishment of bees, contains 70 per cent of grape sugar and 6 per cent of cane sugar (in addition of 22 per cent of water). One can assume therefore that almost the entire quantity of carbon dioxide which is generated by the bees comes from the combustion of grape sugar.

Nitrogen, which bees need, is obtained from the pollen, of which they lay in a supply for the winter. The authoress found by a microscopical examination in winter that the alimentary canal of the bees was filled with grains of pollen. Since, therefore, this nourishment is at their disposal during the entire year, it is clear that the content of nitrogen in the bodies of bees will not change during the seasons of the year, as experiment demonstrates. The quantity of glycogen in their bodies also remains almost constant during the entire year. Since the bees carry carbohydrates into the hive and always have a supply there, they do not need to store it up in the form of glycogen in their bodies.—Wissenschaftliche und Technische Wochenschau.

SUNSPOTS AND MAGNETIC STORMS.

PROF. R. A. GREGORY recently gave the first of two lectures which he had promised to deliver at Queen's College, Harley Street. The subject was "Sunspots and Magnetic Storms," and the lecture was illustrated by a series of limelight views. By means of photographs of the variations of the magnetic needle, the lecturer showed how, in addition to the usual variation of the needle from the direct North, there were occasions when it revealed more irregular disturbances, and this occurred at the time of the magnetic storms of 1892 and 1905, when there happened to be large spots on the sun. In consequence, it had been suggested —and the suggestion at first seemed a plausible one— that the sunspots were the cause of the magnetic storms. This theory was not, however, accepted by astronomers and men of science.

Examining more closely the connection between sunspottedness and the magnetic conditions of the earth, Prof. Gregory showed a table prepared at Greenwich Observatory from the records of the daily photographs of the condition of the sun between the years 1878 and 1905, which demonstrated that the average daily spottedness varied every year, and that the interval between the minimum degrees was between eleven and twelve years. This periodic fever of the sun was thus very definite. The spots themselves did not break out all over the sun's surface, but were confined to two zones a few degrees north and south of the sun's equator. It was a definitely-ascertained fact that just after the minimum of the sun's spottedness the spots began to break out away from the sun's equator and gradually worked down toward the equator. A diagram was shown illustrating the wavering of the magnetic needle, which corresponded with the rise and fall of the sunspots, and the variation also of the Northern Lights, which were caused by the discharge of electricity in the higher atmosphere, so that, the lecturer said, we had the earth's electricity and the earth's magnetism both connected with spots on the sun. These magnetic storms, however, had no connection with the eleven-year intervals he had spoken of; but it had been ascertain that there was an interval of about 27½ days between them, and in all probability that interval was connected with the rotation of the sun on its axis in a period of about twenty-five days. This rotation, however, differed in different parts of the sun—a difference that could only exist in gaseous bodies—and the rotation was the key to the table, which showed an interval of twenty-seven days between magnetic storms. Some part of the sun which was more active in ejecting material than other parts sent out influences that might be related to sunspots, and that disturbed our magnets.

Sunspots were probably storms in the sun's atmosphere and Prof. Hale, director of the Solar Observatory of the Carnegie Institution of Washington, California, had succeeded in photographing the gases separately on the sun's surface. Two photographs were shown of calcium and hydrogen so taken, the hydrogen being in a high state of turmoil, and the lecturer said that Prof. Hale had proved that this vapor, rotating with great velocity, was in a highly magnetic condition, and they deduced the fact that these storms might really be the cause of the disturbances in the earth's magnetism. That was a simple way of stating it; but it was only the beginning of a very difficult inquiry. It had been suggested that it was not the sun which disturbed the earth at all, but that there was a great wave passing through the Solar System, of which both the sun and the earth were victims; but at present the question must be left where it was.

A disposal service for the handling of material excavated at building foundations, building rubbish, ashes from power plants, etc., is being operated by the Chicago Subway Company, which owns a system of some 40 miles of small, deep level tunnels under the city of Chicago. Spurs are run to deep basements or to shafts where the materials are loaded into cars which are hauled by electric locomotives to a disposal station on the west bank of the Chicago River near Madison street. Here there is a shaft, over which are the runways for two electric trolley hoists, each operated by a man riding on the machine. When a car is set at the bottom of the shaft, the body is hoisted up and run out over a dump scow moored alongside the station. The car body is lowered and the bottom released, discharging the contents into the scow. The empty body is then run back and lowered upon the car frame at the bottom of the shaft.

THE GREAT GUANO DEPOSITS OF PERU.*

THE FAMOUS CHINCHA ISLANDS.

ON the coast of Peru, opposite the bay of Pitco, nearly midway the equator and the tropic of Capricorn and something over 100 miles south of Callao lie the Chincha Islands.

These islands and the mainland opposite are in the dry zone of Peru, the *zona seca*, in which rain so seldom falls that aged men can count on the fingers of one hand the times in their lives when they have seen this marvelous thing—water falling from the skies.

These islands are small, high and rocky, barren and uninviting to the last degree, yet out of them has come wealth to stagger the dreams of Oriental imagination. One thousand million dollars has been paid for the guano of the Chincha Islands. Reckoned in gold it would take 15,000 heavily laden pack mules to transport the weight, a train perhaps 30 miles in length.

It is doubtful if there be another spot of equal size on the earth's surface from which so much wealth has been taken as from the guano beds of the Chincha Islands.

But these islands were not the only source of Peruvian guano. The Macabi, the Guanape, the Lobos, the Ballestas, and the Huanillos and the Pabellon de Pica have also furnished quantities of guano. Besides these there are scores of small islands and points along the mainland where guano exists.

The word "guano," or "huano," is the Spanish rendering of the Peruvian word *huanu* meaning excrement. There are many varieties of Peruvian guano having different fertilizing values due to their different chemical constituents, but these were all more or less alike in their origin. They were all mainly the excrement of marine birds mixed with the remains of the birds themselves and perhaps some fish or seal remains.

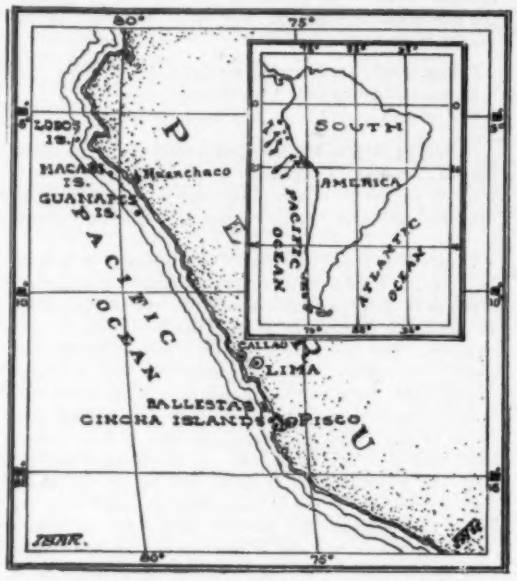
The deposits were from the most recent to the very old. In some cases on the Chincha Islands they reached a depth of 160 to 180 feet. The lower strata of such deposits might be thousands of years old.

Nowhere else in the world are marine birds found in so great quantities as along the west coast of South America from Panama south to Chile. The great majority of these birds have their roosts and breeding places on the Peruvian Islands or on points of the mainland. Their presence in such immense numbers is due to the quantities of fish found along these coasts, upon which the birds feed. Cormorants, pelicans, sea gulls, marine crows, etc., in clouds numbering hundreds of thousands may be seen at any time flying low to or from the islands or hunting their food. But the birds alone could not have produced the Peruvian guano; it was necessary to have the rainless climate of these islands in order to accomplish the result.

There are hundreds of bird islands in other parts of the world, some in the United States, but the excrement and remains of the birds found thereon is not Peruvian guano, although the deposits may be valuable for fertilizing agricultural lands. Even with the Peruvian guano chemical analysis shows great differences.

Manures are of three kinds, as supplying the three constituents needed for plant life, nitrates, phosphates, and potash. These constituents are found in a natural state in all good soils, although generally not well balanced, nor are the two latter found always in an available form. The constituent most often wanting is the nitrogenous, and this is the most easily lost and most costly to supply in any artificial form.

All excrements contain fixed nitrogen in the form of urates and salts of ammonia, but these are to a large extent lost unless the manure is at once applied to the land and even then the nitrogen may be washed out before it can be made available for plant growth. When left exposed to a humid atmosphere for any length of time or rain is allowed to fall on it the fixed nitrogen is rapidly leached out. It is on this account that Peruvian guano, in its natural state, never having been exposed to rain or dampness, has retained its nitrogenous properties, and is more valuable than other guanos. Some Peruvian guano contains all three elements of plant life, and all of it contains the two elements—phosphates and fixed nitrogen. The latter, as has been said, is the most valuable element from a commercial standpoint.



MAP SHOWING LOCATION OF THE GUANO ISLANDS.

When first sent to Europe guano was sold at a fixed price per ton without regard to its chemical analysis. This price was at first as low as $40 or $50 per ton, but later rose to $60 and $70. Subsequently the price was made to depend on analysis, and on the London market, which set the price, it was estimated at 19s. 2d. each unit per cent per ton for the nitrogen and 2s. 3½d. on the same basis for the phosphates, the latter calculated as tricalcic phosphate and the former as ammonia.

The proportion of ammonia varies in the different guanos and in different layers of the same deposit. It may run from a very low percentage up to as high as 25 or even more in the best samples of Chincha guano. The phosphates may run from 20 or 30 up to 75 or 80 per cent. First-class Peruvian guano is such as contains above 10 per cent ammonia.

When the Spaniards came first to Peru they found the natives using guano on their crops of maize, aji, and alfalfa. The deposits were regularly worked, and each village had its proportion of guano from the islands allotted as a necessary element in growing crops, just as it had its proportion of water from the great irrigation canals coming down from the high Andes. The Incas were skilled agriculturists, the early Spanish settlers in Peru were not, so both the irrigation works and the application of guano fell more or less into disuse. But its use was never entirely abandoned, and was known to Spanish writers during the sixteenth, seventeenth, and eighteenth centuries, although practically unknown to the rest of Europe and to North America until well into the nineteenth century.

The credit of first bringing it to the serious attention of Europe is ascribed to Humboldt, who in 1804 brought a specimen from the Chincha Islands, which was analyzed by several of the leading European chemists. But it was not even then that its value was fully recognized, and not until Liebig had taught the world the value of artificial manures was Peruvian guano estimated at its true worth. In 1840 a firm of Lima merchants sent the first cargo to Europe, consigned to a Mr. Myers, of London. Two years afterward the amount transported to England was 182 tons, and twenty years thereafter, in 1862, it was 435,000 tons. Between 1851 and 1860 the amount of shipping that loaded at the Chinchas represented 2,860,000 tons, and between 1853 and 1872 guano to the amount of 8,000,000 tons was shipped from the north and middle islands. In this last year the Peruvian government prohibited the further export of guano from this group.

The Guanape Islands, about 30 miles from Santa, were first worked in 1869, and in three years 838,853 tons of guano were taken off. These are two small islands, the larger less than three-fourths and the smaller less than one-half mile across. About 60 miles north of the Guanapes and 30 miles from Huanchaco, the port of Truxillo, are the three Macabis. Shipment of guano began from these islands in 1870, and two years later the quantity of deposit remaining was estimated at about 400,000 tons. These islands are all north of Lima; the Chinchas are to the south.

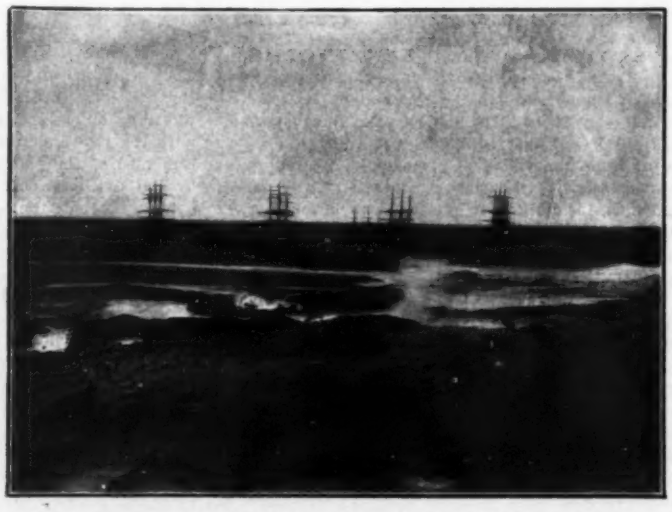
Still farther north and near the Ecuador border is the Lobos group. The outer island of this group, Lobos de Afuera, contained a very large deposit, and the inner island, Lobos de Tierra, another deposit of considerable extent.

However, prior to the war with Chile, which began in 1879, the principal source of exports of Peruvian guano, after the exhaustion of the Chincha deposits, was from Tarapacá, the most southern province of Peru, and which was ceded to Chile at the close of the war in 1884.

These deposits were carefully examined in 1874 and found to exist at the north point of the table-land, which extends to the river Loa in 21 deg. 23 min. S., on an elevated cliff called "Huanillos," in 21 deg. 15 min. S., and at Pabellon de Pica, an immense cone rising from out of the sea 1,000 feet, with slopes formed of guano deposits, in 20 deg. 58 min. S. There were smaller deposits at Chomache, Islotas de Pajaros, Quebrada de Pica, and at Patache.

Estimates as to the original amount of these deposits varied, but it was probably in the neighborhood of 2,000,000 tons. In 1876 there were more than 300 ships taking cargo from these southern deposits.

CHUTE FOR BRINGING DOWN GUANO.



SHIPS LYING OFF SHORE WAITING TO LOAD GUANO.

*Bulletin of the International Bureau of American Republics.

After the exhaustion of the principal deposits on the Chinchas—all the deposits were not exhausted, the decree 1872 prohibiting export preventing this—the export of guano fell off. The amount shipped from this date until the breaking out of the war with Chile was still considerable, about 350,000 tons or over a year. This represented an annual value of over $20,000,000.

During the war the guano industry fell into the

TAKING OUT THE GUANO.

hands of the Chileans. By a decree February 9th, 1882, the Chilean government ordered a sale of 1,000,000 tons of guano, half the proceeds of which were to go to the Peruvian creditors. By the treaty made by Chile with the Iglesias government, which was ratified on March 8th, 1884, and which ended the war and the Chilean occupation, Tarapacá, with the southern guano and nitrate deposits, were unconditionally ceded to Chile. Peru retained all the remaining islands, but the industry was for the time destroyed. The best deposits were worked out, and though during the sixties and seventies a stream of gold reckoned in units of millions had been poured into Peru, the country had but little after the Chilean war to show for it. But the guano beds were not depleted and the myriad web-footed birds sailed up and down the coast, nightly sought its rocky islets, and there bred and reared their young. Guano making was still going on, and with a policy of conservation Peru might draw for centuries a large revenue from the industry. The swarms of fish in the ocean, the rainless climate, and the birds were there. It was then that the policy somewhat similar to that applied by the United States in preservation of the fur-seal herd of the Alaska islands—which policy was successful until the coming of the pelagic seal hunter—was adopted in Peru for the exploration and preservation of the guano industry.

In 1890 a contract was entered into with the Peruvian corporation which had taken over the State railways, giving it the exclusive right to export guano up to 3,000,000 tons. Under this contract the corporation has worked ever since, and the receipts from guano have risen to over $1,500,000 a year.

This contract has not always worked smoothly; there have been many disputes in relation to it, but at the present time these have been for the most part adjusted.

In all the corporation has exported in eighteen years about 1,000,000 tons of guano. The shipments in 1898 amounted to 21,826 metric tons (of 2,204.6 pounds), and in 1899 to 30,795 tons. Since then the amount has increased. In 1905 it was 73,369 tons, worth £285,729; and in 1906, 90,413 tons, worth £361,652. It can be seen that Peruvian guano has not deteriorated in quality, and is still the highest priced and most valuable fertilizer in the world. The exports in 1906 were to five countries—Great Britain, 30.234 tons; Belgium, 26,198 tons; United States, 16,155 tons; Germany, 15,388 tons; and Holland, 2,438 tons. In 1907 about 106,000 tons were taken from the islands, of which amount about 80,000 tons were exported and the remainder used locally. During the year 1909 the only guano exported is that from the islands north of Callao. The deposits to the south are reserved for the uses of domestic agriculture.

No complete survey has yet been made showing the amount of guano deposited on the islands each year. In a report made in March, 1908, to the Minister of Fomento by Mr. Robert E. Coker who had studied the subject in reference to the Ballestas, in one season there were deposited 2,000 metric tons, covering about 20,000 square meters, and on the south island of the Chinchas the deposit covers 60,000 square meters and amounts to 5,000 tons. This guano is of the very best quality.

These two deposits cover a comparatively small part of the territory. The report deals only with two of the groups and of one island only of one of them. On the Guanapes, the Manabis, the Lobos, and the other islands to the north the deposits are many times greater, and if properly protected can be made to yield a sum much greater than that now derived through the Peruvian corporation.

The methods used in working the deposits have not been the best, but these methods are being improved.

Under the old Inca civilization of Peru the guano islands were apportioned to the several provinces of the empire; the deposits were carefully guarded and the manure fairly divided. Closed seasons were enforced, and care exercised that the birds were not unduly disturbed. It has been the policy of the Peruvian government in recent years to revive the old Inca regulations enforcing closed seasons and rotation in digging.

By a decree of December 28th, 1904, the digging of guano between the months of February and November was prohibited under a penalty of $1.95 per ton. This is the beginning of legislation in the right direction for the preservation of this one of the most valuable assets of Peru.

THE NORWEGIAN FISHING INDUSTRY.

THE Norwegian winter cod fisheries begin, as a general rule, during the first part of January each year, and last until June. These fisheries are conducted along the shores of the central and northern parts of the country, the Lofoten Islands from remote ages having been considered the best grounds. During the season the fishermen gather at the several fishing stations in these islands from all parts of the north country. With the modern and larger craft now used, many of them provided with motors, the men are enabled to frequent more distant fishing banks, and it has therefore been found more profitable than formerly to fish much farther south, where the banks are farther out to sea. The fish are seldom taken more than twenty miles off shore along the Lofoten Islands, and the best catches there are often made only two to three miles from shore. Nets, set lines, and hand lines are used indiscriminately. Some 85,000 men, with 19,000 craft of different kinds and dimensions, are annually engaged in the Norwegian winter cod fisheries. The winter cod is prepared for market by the Norwegians in two different ways, either by what is known to the trade as "stockfish," or else by what is termed "klipfish." The latter, according to the American consul at Christiania, is known in Latin countries, where both kinds find their best market, as "bacalao." In the preparation of stockfish, after the head and entrails have been removed, the fish are strung together in pairs by the tail fins, and hung, unsalted, on horizontal poles resting on beams, placed on uprights, where they are left until perfectly dried. For klipfish, the head and entrails are removed, the fish split along the belly, and the upper part of the backbone removed. The fish is then salted, and piled in suitable buildings in regular layers, and finally in due course of time, taken out, worked free of surplus salt, and carefully cleaned of black membranes on the belly side, and then cured in places where suitable flat rocks are found convenient for the purpose. Sometimes more than 100,000 fish may be prepared in this way in one place, giving employment to a great number of persons—mostly women and children. Klipfish is well known under the general appellation of codfish (salted). Among the by-products of cod are the livers, from which is extracted oil prepared either for medicinal or mechanical purposes, and the roes. The roes are, to some extent, prepared and canned for food, and the larger portion is salted in barrels and exported to France and Spain, where they are used at the sardine fisheries. The heads of cod and the backbones of the klipfish are dried and ground for fertilizers. The number of cod and the by-products obtained during the last season were 54,000,000 cod, of which 26,000,000 were prepared as "stockfish," and 24,000,000 as "klipfish," 47,000 barrels of medicinal cod-liver oil, 24,700 barrels of livers for machine oils, and 41,900 barrels of roes. The prices paid to the fisherman vary considerably, according to time and place. The average catch at the Norwegian cod fisheries for a period of forty-two years covered by statistical reports is 50,700,000 codfish per annum, and this figure was reached in 1909 for the first time since the year 1897.

A box of crocodiles' eggs, one of many which had been packed for export, was accidentally left in a storehouse in German East Africa. A few weeks later the box was found swarming with healthy and lively young crocodiles, which had been hatched out in close confinement and without any care. In order to hatch crocodiles' eggs it is only necessary to place them in moist sand which is kept at a temperature of 104 to 113 deg. F. by means of a lamp beneath. The young crocodiles may be fed with raw meat and fish.

CORMORANTS.

Photograph from American Museum of Natural History.

USES OF BAKELITE.*

ITS ELECTRICAL AND ELECTROCHEMICAL APPLICATION.

BY L. H. BAEKELAND, SC.D.

Concluded from Supplement No. 1774, page 11.

Impregnating Processes: Liquid A, specially in its extra thin variety, is readily absorbed by any porous materials. Its penetrating power is far superior in this respect to varnish solutions, rubber solutions, or similar viscous or incompletely dissolved masses which have a tendency to merely stay on the surface notwithstanding the aid of high pressure.

If a piece of non-resinous soft wood, like basswood or poplar wood, be immersed in extra thin liquid A, after a few hours it will be found that the wood has doubled or even tripled its former weight. The absorption of the liquid is accompanied by some swelling of the wood and the latter becomes translucent on the edges, which shows that the interior of the individual wood-fibers is entirely filled. The same treatment can be given to unsized paper, paper pulp, cardboard, asbestos, objects of cement, or plaster of Paris, in fact, to any material of a fibrous, cellular, or otherwise porous texture.

For such articles which absorb easily, regular liquid A can be used, although it is somewhat thicker; in this instance slight heating will render it more fluid. In other cases it becomes necessary to use extra thin liquid on account of its greater penetrating power. The addition of solvents like alcohol or others does not work well except in special cases, as for instance, thin sheets of blotting paper, because these solutions do not seem to penetrate as well; furthermore, the use of solvents introduces a new factor which retards the synthesis.

Resinous woods like pine are very difficult to impregnate. Bass, poplar, and similar woods, as well as unsized pulp board are easily impregnated by plain soaking, and this can be helped by the usual methods of injection under pressure. The preliminary use of a vacuum does not seem to be so advantageous from the fact that when liquid A enters the vacuum chamber it dissociates, evolving formaldehyde gas, and the liquid starts boiling and foaming violently. I found it much simpler to heat the substance that has to be impregnated at about 120 deg. C. for several hours until all water and air is expelled and then to immerse the objects, while they are still hot, into the liquid A, where they are left to soak; if more complete impregnation is desired, the force pump may be resorted to.

The impregnated material is now transferred to the bakelizer and submitted there to final treatment.

It should be borne in mind that we have to deal here with chemical phenomena occurring in capillary spaces. Under the latter conditions chemical reactions are considerably retarded. The chemical dynamics here are much influenced by decreased mobility of the reacting molecules. For this reason it is necessary to heat longer than for ordinary conditions.

On the other hand, the capillary conditions depress at the same time the tension of dissociation; this explains why wood or cement impregnated with liquid A can be heated at temperatures somewhat above 100 deg. C., without applying pressure and yet not give a porous result. So under these special conditions a bakelizer can be dispensed with by raising slowly the temperature from 70 deg. to 130 deg. C. But even then we have to guard against a considerable loss of formaldehyde vapors which are set free during the first period of heating and which may prove a disturbing factor by altering too much the chemical composition of the impregnating material.

So that, after all, whenever heating in a bakelizer is practicable, it ought to be preferred even if only for the fact that it will shorten the heating process very considerably.

It is advisable to supplement the treatment with a slow after-drying so as to expel any traces of water which may have been liberated during the synthesis.

In most instances it will be found that the impregnated objects have a dull appearance on the surface. Whether this be due to the fact that the pressure in the bakelizer has forced the liquid inward, or whether it has to be ascribed to surface evaporation, it can be easily remedied by applying a second superficial coat of thicker A.

The latter is best applied while the objects are still hot; this treatment will impart a very hard and very glossy surface.

Wood thus treated is not only much harder and stronger, but it has become rot proof, and is a better electrical insulator. It withstands dilute acid solutions and ordinary electrolytes. It can be used to excellent advantage for third-rail covers. Similar usages can be found for impregnated pulp board, cardboard, and asbestos board.

Asbestos paper or asbestos tissue impregnated with A or B, makes an excellent packing material for gaskets, washers, and similar purposes.

In that condition it can be carried in stock indefinitely, either in the form of flat sheets or in ready-made sizes. As soon as this packing material is applied to a hot surface under pressure, the A becomes plastic and molds itself thoroughly over the surface and is gradually transformed into hard permanent C.

In certain cases, the admixture of graphite or similar filling materials may prove advantageous.

The impregnation of coils for dynamos, motors, and transformers: Bakelite gives us a ready means to provide these apparatus with a hard and strong insulating mass which cannot soften under the influence of heat, and withstands temperatures at which all hitherto used gums or resins would melt away. Every electrical engineer knows what this means in relation to running "overloads."

But the use of bakelite for these purposes involves new questions in the technique of impregnation. It should not be forgotten that by the synthesis of bakelite, a certain amount of water is set free and this water must be eliminated from the coils by after drying. Furthermore, bakelite in its final state C, although very hard and tough is not flexible; so that any wires or conductors coated with it can no longer stand much bending or twisting, and for such parts, the bakelizing operation should only take place after all wires and conductors are in their final place.

With this aim in view, the wire or conductor, provided with its covering of cotton or asbestos can be simply coated with dissolved A solution properly diluted with the necessary amount of alcohol, then submitted to spontaneous drying. This may be helped by a gentle application of heat, but never more than is necessary to carry the material to the stage B, so as to maintain the necessary flexibility. The wire is now wound as usual, and in order to insure more flexibility it may be found useful to heat it slightly. Tape or any fabric, or asbestos impregnated with A, may be put between successive layers, just as is done when shellac is used as an insulator; after the coil is made up it is now introduced in the bakelizer.

In case the wires are covered exclusively with asbestos it will be advantageous to heat the bakelizer at highest temperatures; however, if cotton or similar organic materials be present, such high temperatures would destroy and carbonize them and it may be safer not to exceed 140 deg. C. After bakelizing, the coils should be submitted to slow drying so as to expel any remaining traces of moisture or solvents, and this operation can be hastened considerably by the use of a vacuum dryer.

In other cases ready-wound coils may be simply impregnated with liquid A, using the precautions as described for the impregnation of wood. Capillary conditions as described for the wood impregnating process exist here; so that, with some precaution it is possible to slowly transform A into C or at least into B, in an ordinary drying stove, without the absolute necessity of resorting to a bakelizer; always, provided the heating be started at temperatures as low as 60 deg. to 70 deg. C. and gradually increased to 120 deg. to 140 deg. C.

In fact it may be found sufficient not to go beyond B and leave it to future self-heating of the wire when run under overload to arrive at the final condition C.

It ought to be mentioned here that in such coils with many layers of metallic wire, the outer shell of B may act as an envelope which insures internal pressure during the heating process, just as if it was in a closed vessel, and thus prevents dissociation and the resulting formation of a porous mass.

As a modification to above methods, I should suggest the following:

The coil after being properly impregnated may simply be put in an accurately made closed mold and the latter may be filled with more A, using pressure if required, so that after bakelizing the same the whole will come out in accurate size and shape and present a much neater appearance than the ordinary clumsy coils now in use for dynamo and motor construction. The very fact that henceforth it is possible to mold coils in regular shapes and most accurate dimensions, may ultimately simplify the construction of this class of machinery and render renewals much easier.

Coating Processes: The simplest way for coating an object with bakelite is to dip it in liquid A and then finish it in the bakelizer. By slightly heating the objects and by using rather thick A, the operation becomes rather simple, especially for metallic objects. Or the A coated objects may be first heated gently in a stove until the A has been transformed in B and then the object may be transferred to the bakelizer. Several coats may thus be applied in succession until any desired thickness is attained. This method of building up a thick coat by several layers takes away the danger of cracking or splitting when thick coats are applied all at once.

The sudden contraction during polymerization has to be taken into consideration here. There is another way of counteracting the effect of too much contraction, namely, the incorporation of suitable filling materials as silica, or fine sand, clay, slate, dust, powdered asbestos, etc. Any of these materials added to liquid A in suitable proportion will give a putty-like mass which can be easily kneaded, specially if slightly heated; it can be applied and modeled to any kind of surface to the desired thickness and shape. This same mass can be rolled out in thin sheets, and the latter can be applied on the inside and outside of metallic vessels. The whole can be directly finished in the bakelizer or be heated previous at low temperatures so as to bring it first in B state. This method gives a ready means for covering iron pipe or pumps or similar objects with a layer of protective material, and thus render them more suitable for chemical engineering purposes. Thick layers of bakelite without filler, or mixtures containing little filler, do not adhere well to metallic surfaces. But by using more filler, and specially by using gritty materials as fillers, like sand or abrasives, the adherence becomes excellent. For instance, mixtures of emery with about 10 to 15 per cent liquid A, can be made so that after bakelizing they will stick to glass to the point that they can no longer be removed unless by chipping off pieces of the glass.

A composite coating of bakelite can also be applied on wooden or metallic vessels by first dipping a sheet of asbestos in A, partially transform it into B by heating, then stick it, by means of thick A, to the surface which is intended to be protected, and afterward press it against the surface by means of a hot, smooth plate. The latter operation is finished in about ten or fifteen minutes if the pressing plate is maintained sufficiently hot. By selecting polished metallic pressing plates, a very beautiful finish can be obtained at the same time. In this case bakelite not only acts as impregnating and finishing material, but also as an excellent and permanent adhesive.

A modification of this method has given splendid results for veneering and finishing wood, accomplishing in a few minutes results which heretofore could not be obtained after weeks of polishing, sandpapering, and varnishing with the older methods as practised by piano and furniture manufacturers.

A similar method may become useful for lining wooden or metallic boxes with impregnated asbestos so as to make them suitable for electrolyzing tanks or storage batteries.

Whenever very thin layers of bakelite have to be applied, it may be simpler to use A in alcoholic solution as a varnish; for this purpose, dissolved A, properly diluted with three to four times its volume of wood alcohol, is very suitable. This can be done by brushing, dipping or spraying. This varnish dries in a few minutes to a point where it is no longer sticky, but it may take several hours before it is entirely dry. Even then the last traces of solvent are not expelled entirely, and even after years the layer remains A, soluble and fusible. If temperatures above 100 deg. C. are applied, we may get nearer the stage C, but there is a decided tendency toward blistering, especially in such spots where the varnish has been applied rather thickly.

The use of the bakelizer prevents all this, and for wood or other materials which have a porous surface it is entirely indispensable. For metallic surfaces, by using great precaution and thin layers, and by raising the temperature very gradually until it attains 120 deg. to 140 deg. C., a hard coating may ultimately be obtained.

* A paper presented at the Fifteenth General Meeting of the American Electrochemical Society at Niagara Falls, Canada, May 6th to 8th, 1909. See SUPPLEMENTS, Nos. 1768 and 1769 on Bakelite.

Sheet iron, or stamped boxes provided with a thin coating of bakelite, can stand boiling dilute sulphuric acids and boiling neutral solvents.

It should be borne in mind that on account of the limited flexibility of bakelite, such sheets cannot be twisted or bent beyond certain limits without splitting the protective layer. In any such cases where bending has to be done, it must be done before the varnish is applied or after the A has been changed in B, which still leaves some scope for flexibility.

Molding Processes: The simplest but slowest way for molding bakelite is to pour liquid A, alone or mixed with fillers, in suitable molds and heat in a bakelizer. This operation may take as much as one to three hours, according to the temperature or the size of the object; so that this process has the objection of requiring the relatively long use of molds. It can be shortened by simply carrying the heating process until the B stage, after which the object can be expelled from the molds and finished in the bakelizer at any suitable time thereafter and without the further use of molds. The B stage can be obtained by plain but slow heating in a stove or water bath, or by rapid heating in the bakelizer. But even all this is too slow for many purposes where quick and accurate molding is essential. It then becomes simpler to mold in a hot press. For this purpose a hydraulic press, or a screw press, or even a lever press can be used, as long as it is provided with contrivances whereby the platens can be heated and cooled quickly, either by steam and cold water circulation, or by gas heating. Temperatures as high as 200 deg. C. are desirable for rapid and best work, but the molding can be done also at 80 pounds steam pressure. It is a noteworthy fact that molds under high pressure contact with the platen, heat up and cool quicker than if not under pressure.

I tried first mixtures of liquid A with various filling materials, the mass being mixed between rollers same as are used in the rubber industry, but I found afterward that this slow and expensive method of mixing is entirely unnecessary if solid A be used.

Furthermore, liquid A has the disadvantage over solid A of requiring a longer time for molding. Solid A has the great advantage over other plastics in that the first action of heat liquefies it entirely, so that high pressures as required for molding celluloid, rubber or resinous materials are superfluous unless large amounts of filling materials be used which make the mass less plastic. After the first liquefying action of the heat, the immediate after-effect is quite contrary; namely, the hardening of the mass while A becomes B, then C. The main function of the pressure in the act of molding A is to counteract the dissociation which would cause porosity and resulting lack of homogeneity. This explains why astonishingly accurate molding—for instance, talking machine records—can be made with bakelite under low pressure, provided sufficient heat be used. Persons who are familiar with the molding of celluloid, shellac or rubber compositions, when trying bakelite for the first time are apt to heat the molds insufficiently, being under the wrong impression that high temperatures may spoil bakelite in the same way as the compounds to which they are accustomed.

The great penetrating power of A makes it possible of making molded objects containing as little as 10 per cent, and even less of bakelite, the remainder being made up of suitable fillers, for instance, asbestos.

Quantities of 20 to 30 per cent of solid A, and 80 to 70 per cent of asbestos, make excellent compositions for molded insulators.

In some cases it may be found desirable to increase the amount to about 40 per cent. Wood pulp or ground sawdust require these larger proportions if the objects have to stand boiling water without losing their gloss.

The mixing of these compounds is very simple work. The solid A is pulverized in a porcelain ball mill, and ground to 50 or 100 mesh. If trouble is experienced on account of the ground material sticking to the walls of the mill, this can be easily obviated by adding about 10 per cent of the filler, which prevents "caking." The so ground A can be kept in reserve for further use. It is then mixed in suitable proportions with the finely powdered filling materials, and reground in a ball mill so as to insure thorough mixing. This mixed powder is now ready for molding; on account of its bulkiness it may be found preferable to compact it somewhat by pressing it slightly or rolling it into sheets while being gently heated. The resulting sheets or cakes can be kept in stock. To use these for molding they are put into the slightly heated molds, and the latter are pressed now between the very hot platens of the press, which squirts out any excess of material. Pressing and heating is continued until the A is transformed into B, after which the molds can be emptied. According to the size of the molded objects or the temperature molding is finished in a time varying from twenty-five minutes to three minutes, and even less for small objects.

Molded objects of bakelite in B condition are about as strong as shellac, but they still soften under the influence of heat. They become considerably stronger, and acquire their final resisting qualities by being heated in the bakelizer. This final treatment can be carried out at any suitable time, all the pieces being put in together. No molds are needed here because B, although soft while hot, does not melt any longer, and keeps its shape while submitted to the high heat of the bakelizer.

We here observe again a slight shrinkage of volume, which has to be taken into consideration while designing the molds. This contraction is always the same for the same compositions, and becomes very small if large amounts of fillers are used. By taking these factors into consideration the molding can be done with an accuracy of 0.001 inch or better.

We have stated above that C cannot be molded; it is no longer plastic; in other terms, its particles if pressed together do not give a strong coherent mass where all the particles are welded homogeneously together.

On the other hand, B, although infusible and insoluble, softens when heated under high pressure, and welds and molds together.

This enables us to still further simplify the molding operation by using ground B instead of A. But it then becomes necessary to use maximum temperatures and highest possible pressure, B not flowing so easily as A. This is specially indispensable when large amounts of filling material are employed. This method of working is decidedly advantageous when a highly polished surface and very accurate molding is desired. By keeping long enough in the mold, no after-treatment in the bakelizer is required, and the gloss imparted by a polished mold is thus kept intact. The use of B is also advisable in such instances where mixtures rich in bakelite are desired. Whenever mixtures are made containing over 40 to 50 per cent of A there is constant danger that during the act of molding the A may ooze out before it has had time to be changed into B. By using directly B this difficulty no longer exists, and there is no further limit to the quantities which may be employed in a molding mixture.

For such molded electric insulators which are expected to stand high temperatures, finely ground asbestos, clay, mica or other similar mineral fillers should be used. If temperature specifications are not so important, then organic fillers like wood-pulp or ground sawdust are available, and give nicely molding compositions of which the insulating coefficient is frequently considerably higher than that of asbestos. Some varieties of Canadian asbestos prove to be much less desirable for high voltage insulation; this is probably due to mineral impurities, and to the higher content in water. These differences in insulating properties do not play much importance for voltage below 40,000. On the other hand, asbestos, on account of its fibrous texture, lends great strength to bakelite compositions, and makes them stand better the shattering effect of direct impact or concussion.

The difference in insulating properties of asbestos is clearly shown by comparing results with a sheet of blotting paper impregnated with bakelite, and of asbestos paper of the same thickness, treated in the same way. The impregnated blotting paper may puncture at voltages two and three times higher than the asbestos sheet.

Bakelite compositions lend themselves more or less to kneading, filing, and sawing, according to the nature of the filler. In this direction, compositions containing fibrous materials show again the best results.

I have stated before that bakelite alone can stand 300 deg. C., but compounds which contain large amounts of mineral filler may be made to stand even higher temperatures. Those containing wood-pulp, sawdust or other organic fillers will stand less, the filling material being destroyed before bakelite.

It is a well-known fact that whenever rubber is used as an insulator it slowly emits sulphur vapors, which by and by attack metallic parts, and may cause serious injury to delicate copper wires or metallic connections. Bakelite, not emitting any such objectionable emanations, does not possess this defect, and therefore has been preferred in the manufacture of delicate electrical instruments.

But I have not yet mentioned another advantage of bakelite insulators over those made of shellac or other resinous materials.

It is a known chemical fact that the latter are all apt to hydrolyze by the action of water or dilute alkalies. This action is readily shown whenever water is dripped on a table varnished with shellac which causes whitening on the wet spots. This effect is more pronounced whenever a small amount of ammonia is present. A similar action occurs whenever the conditions of the atmosphere deposit a thin film of moisture on shellac insulators, so much the more as the air always contains traces of ammonia. This superficial hydrolysis which forms on the surface of resinous insulators a thin film of conductive, chemically changed resin, may explain the so-called "creeping" of high voltage currents along the surface of resinous insulators. The very fact that bakelite can be heated in presence of water and ammonia in an autoclave at 200 deg. and over without hydrolysis makes us feel safe as to its resisting power to atmospheric influences.

Whether bakelite-asbestos or bakelite-mica insulators will answer the purpose for high voltage insulation as well or worse than porcelain is a matter which experience and the test of time alone can decide.

For insulation in third-rail systems, where continuous vibration of passing trains plays havoc with brittle and unreliable porcelain, bakelite-asbestos has indicated decided superiority after several months of continuous service, as well as by direct laboratory tests;

ELECTRICAL TESTS.

No.	Name of Piece.	Bakelite.	Remarks.
1	Spool	Punctured at 16,000 to 18,000 volts	Asbestos hard-rubber composition punctured at 4,000 to 8,000 volts.
2	Square tube (hollow) thickness, 0.163 inch	Punctured at 21,000 volts	Asbestos hard-rubber composition punctured at 17,000 volts.
3	Washer thickness, 0.062 inch	Punctured at 20,000 volts	Asbestos hard-rubber composition punctured at 11,000 volts.
4	Disks of various compositions. Thickness, 0.0625 inch Thickness 0.162 inch Thickness, 0.165 inch Thickness, 0.375 inch	Punctured at 45,000 volts Punctured at 31,000 volts Punctured at 22,000 volts Punctured at 42,000 volts	These tests are still unfinished and were made on various bakelite compositions. None on pure bakelite.
5	Disk. Thickness, 0.095 inch	Punctured at 18,000 volts	Asbestos hard-rubber composition punctured at 1,500 volts.
6	Cup insulator. Thickness, 0.375 inch	Punctured at 42,500 volts	
7	Line insulator	Arc to pin, dry at 50,000 volts	Used on 11,500 volt line.
8	Rail insulator	Resistance dry: 5,625 megohms. Resistance wet: 0.5 to 65 megohms. (These tests are only approximate in megohms.)	Porcelain resistance dry: 4,550 megohms. wet: 0.2 to 10 megohms.
		Arc over hook bolt to rail 27,000 volts	Porcelain arc over 26,400 volts.

MECHANICAL STRENGTH TESTS.

No.	Name of Piece.	Bakelite.	Remarks.
2	Square tube (hollow), thickness, 0.163 in.	Traverse strength, 4-inch centers, 1,850 pounds	Asbestos hard-rubber composition, 1,700 pounds.
8	Rail insulator	Ultimate strength compression, 98,000 to 110,000 pounds	Porcelain 45,000 to 85,000 pounds.
		Ultimate strength tension, 3,200 to 5,500 pounds	Porcelain 1,400 to 2,300 pounds.
		Impact test, no limit found for same blow as porcelain was submitted to	Porcelain 38 to 100 blows.
9	Cup piece, hollow cylinder 3 inches high, 1¾ inches diameter, 0.045 inch thick	Ultimate compressive strength 2,550 pounds	Loaded on top.

HEAT TESTS.

No.	Name of Piece.	Bakelite.	Remarks.
10	Valve interior	At 265 pounds, steam about 460 deg. Fahr. for one hour	No effect on the composition.
11	Packing nut. Graphite composition	Tight at 65 pounds, steam 200 r. p. m.	Could turn 3-inch shaft by hand.

NOTE.—All of the bakelite insulation shows an unusual uniform resistance at varying temperatures from 0 deg. to 300 deg. Centigrade, and does not soften at much higher temperatures. Most of the insulation contained about one-third bakelite and two-thirds finely divided asbestos.

besides greater strength, it has shown more regularity in manufacture, and allows more accurate molding, which permits closer designs and smaller margin of safety.

There is no difficulty whatever in imbedding metallic parts, like bolts, cores, screws, washers or reinforcing members, in the molded mass.

In the tables are condensed some comparative results which have been communicated to me by users of bakelite who previously had acquired great skill in the manufacture of other excellent insulating compounds, and by this fact were better able to draw comparisons.

Before leaving this subject mention should be made of the properties of special mixture of bakelite with graphite, of which I have here some specimens. Both these materials compound very well together in almost any proportions. Liquid A or solid A can be used for this purpose. By varying the amounts of bakelite, these compositions may be made of varying hardness, from such ones as write on paper like the softest pencils, to others which are so hard that they no longer leave a tracing when rubbed against a rugous surface. I do not know in how far this may be utilized in the pencil industry, but I have obtained some very encouraging results by trying to use them for self-lubricating bearings. The fact that such bearings can be molded very accurately at little cost makes their interchangeability and rapid renewal a very easy matter. Dynamos or motors or other rapid revolving machinery, where lubrication is a delicate matter, might be provided with such bearings instead of the older metallic bearings. Bakelite-graphite bearings will not melt nor soften in case of overheating; they can be used in conjunction with oil like any other bearing, and in case of insufficient supply of oil the graphite present will supply the necessary lubricant.

As a lining for pumps which are required to handle liquids which corrode iron, the same mass may find its uses.

But bakelite-graphite composition presents other possibilities from an electrical standpoint. It namely gives us a means of producing a material of which the electrical resistance can be changed at will in a very wide range by changing the proportion of bakelite.

Finally, I might mention that I have tried to decrease the porosity of graphite anodes in electrolytic cells by the injection of extra thin liquid A, and bakelizing afterward, but although in a first experiment we were able to decidedly decrease anode corrosion, I am not sure whether this was due to direct action or to a somewhat lessened conductivity. This may be a suggestion for Dr. Turrentine in his experiments with graphite as electrodes for electrolytic analysis.

SCIENCE NOTES.

In order to eliminate all danger of infection from dirty milk bottles, and to place the distribution of whole milk on a strictly sanitary basis, the New York Milk Committee, in its seven infants' milk depôts, is using for the first time in New York city a single service paper milk bottle, which it instructs its patrons to throw away as soon as it is emptied of milk.

It is expected that aluminium coins of low value will be in circulation in France by the end of this year. It is interesting to note, in this connection, that the adoption of M. Naquet's proposition for an aluminium coinage in 1871 would have resulted in a heavy loss to the French Treasury. Although experts declared it to be impossible that the value of the metal should decrease, it has now fallen to nearly half the price ruling thirty-eight years ago.

An article in the Genie Civil states that seventy-eight electric furnaces now exist in the steel works of the world, of which thirty-five are on the induction and forty-three on the arc principle. Fourteen are Kjellin furnaces, eleven Stassano, ten Röchling-Rodenhauser, three Elektrometall Society (Sweden), and one each Colby, Hiorth, Keller, Schneider, and Wallin. There is a steady and marked tendency to increase the capacity of these furnaces, some of those already constructed holding as much as eight to ten tons.

Measurements and estimates from mariners and observers at sea indicate that the average height of all the waves running in a gale in the open ocean is about 20 feet, but the height of the individual waves is often found to vary in the proportion of one to two, and there is, in fact, in a fairly regular sea a not inconsiderable range of size among the waves. In any statement that we may make as to the size of waves in a gale on the ocean we should not neglect the mention of the larger waves that occur at fairly frequent intervals. These, which may be termed the ordinary maximum waves, are perhaps what seamen really refer to when they state the size of the waves met with during a storm at sea. "About 40 feet" is a common estimate of the height of the larger waves in a severe gale on the North Atlantic, and this estimate is really not incompatible with a recorded average of a little more than 20 feet. It is difficult to say what may be the greatest height of the solitary or nearly solitary waves that are from time to time reported by mariners. The casual combination of the numerous independent undulations running on the sea presumably sometimes produces two or three succeeding ridges or two or three neighboring domes of water of considerably greater dimensions than those of the ordinary maximum waves of a storm. Although these large cumulative waves may be frequently produced, yet they will be comparatively seldom observed, because so small a fraction of the ocean's surface is at one time under observation. There are seemingly reliable accounts of cases in which these "topping seas" have reached the height of 60 feet.

ENGINEERING NOTES.

From a report of comparative tests made by an American trunk line on the new ferro-titanium steel rails and those of the Bessemer type it is noted that the wear on the former showed 1.45 pounds per yard, as against 4.18 pounds per yard on the latter, which is nearly 300 per cent in favor of the new alloy steel.

Rain gutters at the eaves and headers have been dispensed with in the buildings of the new Scranton locomotive shops of the Delaware, Lackawanna and Western Railroad, thus doing away with the numerous troubles experienced with them. The roofs project about 12 inches beyond the walls, and the drippings are caught in a monolithic concrete gutter at ground level, which is sloped to perforated drain covers placed at convenient intervals. The gutter is a dished slab molded in place against the building.

The smelter production of lead in the United States in 1908, as given by C. E. Siebenthal, of the United States Geological Survey, under the date of May 24th, was 408,523 tons of 2,000 pounds, against 442,015 tons in 1907, and 418,699 tons in 1906. The production of refined primary lead, which embraced all desilvered lead produced in the country, and the pig lead recovered from the Mississippi Valley lead ores, was 396,433 tons, against 414,189 tons in 1907, and 404,669 tons in 1906. The antimonial lead produced was 13,629 tons, and the recovered or secondary lead 18,283 tons. In 1908 the lead smelted from domestic ores was 310,762 tons, and from foreign ores and foreign base bullion—almost wholly Mexican—97,761 tons.

Experiments with concrete telegraph poles by the Pennsylvania Railway have met with such success that the executive officials of the line have decided gradually to extend their use over the Fort Wayne, Panhandle and other lines west. Before many months it is possible that old wooden poles along the lines in that vicinity will be replaced by concrete. No definite sum of money has been put aside for this purpose, but it is understood that the engineering department has been given orders to prepare to use concrete poles. The instruction and improvement programme for 1910, which will be decided upon shortly, is expected to include orders to place many miles of concrete poles on the lines west.

During the first half of the last century it was solid fuel only that was employed for the generation of heat and power, but the last half of the century has seen the advent of liquid and gaseous fuels, which under certain conditions proved themselves of the greatest value, and certain processes are now largely dependent upon their use, this being due to the ease of application which has meant economy in labor and greater facility for converting the heat into work. As an example of the ease of application making a fuel of poor calorific value more effective in use than coal of high quality, one may instance such manufactures as those of glass, where in the heating by solid fuel the necessary temperature had to be imparted to the mass of raw material through the walls of a thick fire-clay retort, the difficulty of application here being dependent upon the fact that the crucible had to be heated to a very high temperature to get the necessary fusing point of the glass mixture, and that maintaining this for a considerable period meant a big expenditure in fuel and great wear and tear to the furnace and containing vessel. It was clear that if the fuel could be gasified and the clean flame made to play directly onto the surface of the mixture to be fused, instead of having to impart the heat through the walls of the containing vessel, an enormous economy would be obtained, and this is now done by the utilization of producer gas and regeneration in the continuous tank process. In the same way liquid fuel, as soon as methods could be found for its proper combustion, presented such wonderful economies and advantages for marine work that, in spite of its being dearer than coal, it at once found a place in both the navy and merchant marine. The possibility of being able to store it below the level of the boiler in the ballast tanks instead of having, as in coal bunkers, to have the storage above that level, at once gave increased space in the important part of the vessel, and, what was of much greater importance in the service, the being able to carry a larger supply of latent energy in the same space as the coal occupied increased the radius of action of the vessel.

ELECTRICAL NOTES.

The United States government have issued returns as regards telegraph and telephone systems in the country, and, from particulars published by the Telegraph Age, it would appear that there are 65 miles of wire in the Republic of Panama, 484 miles in Puerto Rico, 1,403 miles in Alaska, and 6,438 miles in the Philippines. These systems handled over 1,000,000 messages. The Weather Bureau controlled 537 miles of wire and 96 miles of submarine cables, and 2,280 places were supplied with forecasts, 734 with special warnings, and 5,998 with emergency warnings, all this being done at the expense of the government. Daily forecasts were sent to 2,141,151 addresses. Puerto Rico boasts of 128 offices and 1,774 miles of wire, and the traffic amounted to 216,489 messages.

As a result of the active agitation which has been carried on for some time in favor of the compulsory conversion of all steam railways entering the city of Chicago to electric traction, states Electrical Engineering, the City Council have drawn up an ordinance requiring all railways within eight miles of the city hall to adopt electrical power after January 1st, 1912, in accordance with plans approved by the Commissioner of Public Works. There is considerable opposition on the part of the railway interests, but the city officials consider the legality of the ordinance unquestionable. The ordinance has yet to be reported on by the committee on local transportation, but in the opinion of our contemporary there is every likelihood of its being finally carried.

Some electric motor coaches are being built for suburban service on the New York, New Haven & Hartford Railway. These cars are designed to operate on both the 11,000-volt-alternating-current overhead system used on the main line and on the 600-volt direct-current, third-rail section used near the New York terminus. The cars are intended to pull trailers, and are equipped with four series-compensated motors. These and the step-down auto-transformers are supplied with forced ventilation from the blower system. When the equipment is operated under forced ventilation the one-hour rating of each motor is 200 horsepower. Each car is guaranteed to haul two 50-ton trailers, and when so operating will accelerate normally at a rate of 0.7 mile per hour per second.

In a recent issue of the Electrical World a patent issued to Mr. B. Frankenfield is described. The claim relates to an arrangement whereby the load on several shunt-wound direct-current motors connected in both mechanical and electrical parallel can be divided equally among the machines. Each motor is provided with as many separate field coil sections as there are individual motors, the sections on one machine being joined in series with those on the other machines. The arrangement is such that any change in the field circuit resistance of one machine varies the strength of the fields of all the machines equally. This action prevents any motor from taking more than its share of the load, as would be the case if the motors were independently connected to the supply system and the field winding of one became hotter and therefore admitted less current than the field winding of another motor.

A detailed study of the lengths of the waves emitted by many of the ordinary forms of generators of short electric waves has been carried out by Messrs. H. W. Webb and L. E. Woodman at Columbia University, and the results are given in the August number of the Physical Review. The object of the authors was to establish such definite relations between the dimensions and electrical properties of the generators and receivers of the waves as to enable future workers to calculate the wave length with certainty from the dimensions of the apparatus used. The method employed was Boltzmann's, the beam sent out by the generator being reflected at two mirrors, and the two half beams brought together to produce interference. Rod, cylinder, Righi, and other generators were tested, and the wave length measured in each case, a non-selective receiver being used. For apparatus of the same type, but of different size, the wave length is proportional to the linear dimensions of the apparatus.

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